# span

SHELL PUBLIC HEALTH AND AGRICULTURAL NEWS VOL. 3 NO. 4. 1960

17 NOV 1960

# span

VOL. 3 NO. 4 1960

**Shell Public Health and Agricultural News**
*is published quarterly by Shell International Chemical Company Limited, St. Helen's Court, Great St. Helen's, London, E.C.3, and is distributed by Shell Companies throughout the world.*

*The Editor invites readers to submit contributions (if possible typed, double spacing) for publication in* Span. *Authors are free to state their own views and the opinions expressed in articles are not necessarily shared by the Editor.*

*Articles written by members of Shell Companies may be reproduced in other publications without written permission provided acknowledgement of the source and the author's company is made. Editors wishing to reproduce articles by independent contributors are asked to seek permission from* Span.

Agricultural Production in Tropical Africa. *J. E. Mayne* 138

Land Reclamation in Holland. *D. Bakker, et al.* 143

Colonial Pesticides Research Unit, Arusha. *K. S. Hocking* 152

International Grassland Congress. 156

Chemical Ploughing in New Zealand. *L. J. Matthews* 160

Malaria Eradication in India. *Rajindar Pal* 164

Transport and Handling on the Farm. *J. A. C. Gibb* 168

Farm Management and Work Study in Britain. *G. W. Lugg* 172

Weight or Volume? *R. E. Gill* 176

Modern Seed Dressing Methods. *A. Hedén* 178

Handling Pesticides Safely. 181

Books. 184

# Agricultural Production in Tropical Africa

*by* **J. E. Mayne**

*Any attempt to survey the agriculture of tropical Africa in one article must needs be an exercise in compression and the author points out that it has not been possible to describe the important research, surveys and pilot schemes that are in hand; also that no mention has been made of international cooperation in technical matters (including control of locust swarms) or of the excellent standards achieved by many of the European farmers in parts of Central and East Africa. It must be realised, too, that irrigation possibilities are being explored and developed, and ways and means are being found of financing major development schemes.*

In general, tropical Africa is the part occupied by the Bantu peoples. A hundred years ago it was known to Europeans only as an inhospitable yet remarkably compact coastline. The country within was of little interest; nothing much was coming out of it except ivory and slaves. Ashore, the trade in both commodities was at that time almost a monopoly of Arabs aided by the indigenous chiefs, so there had been little encouragement and still less cause for European encroachment into tropical Africa.

The slave trade must be mentioned because over a period of 200 years or more it helped to deprive many African tribes—especially the peaceful agricultural ones—of much of their vigour by removing many potential workers to Asia and America. Livingstone once estimated that every year 350,000 people were removed by the slavers. Additional devitalising factors included sleeping sickness, malaria and dysentery.

One of Africa's physical disadvantages having a direct effect on agriculture is the unreliability of the rivers. They are not fed by slowly melting glaciers. Even those originating from great lakes are not very steady, being influenced by their capricious tributaries long before they reach the restricted coastal plains. Irrigation is not common in the area.

Broadly, tropical Africa has three parts: a massive upland region incorporating the Sudan and linking it with the Kalarhari Desert; the coastal lowlands which flank the uplands to east and west and are especially extensive and important in a swathe 2,000 miles long from the Senegal river to the Niger; and thirdly, the Congo basin. The extreme uplands, lying in a 3,000-mile chain from Eritrea to Matabeleland can boast several peaks rising to almost 15,000ft. but the general altitude is about 4,000-6,000ft. The western side of the upland area is dominated by the Bamenda Highlands and the Bihé Plateau; in the middle lies the vast bowl of the Congo linked by a tortuous passage with the Atlantic. If the usual cyclic phenomena of the equinoctial zone are applied the climatic and ecological picture emerges.

The Congo basin and much of the West African coastal strip are tropical rain forest areas around which—and especially to north and south—lies a broad band of savannah, sometimes with tall grasses, sometimes short, and variously speckled with open woodland or scattered trees. At the core is the natural oil palm belt. Northwards, where the savannahs merge with the desert shrub country of the Sahara, lies the southern limit of the date palm. The area between is transitional, occupied partly by nomadic herders and partly by settled tribes growing annual crops (especially groundnuts, cotton and sorghum, with maize included where there is enough rain). In a less marked way this pattern is repeated in the south, while to the east, although recognisable, it is severely disrupted by high mountainous terrain where sub-tropical or even temperate conditions exist in places.

Throughout tropical Africa there are basic forms of indigenous agriculture related directly to the climate, soils, tribal characteristics and immediate needs of the inhabitants. At the other extreme, superimposed on the basic agricultural pattern and linked by road and rail with the

coast, there are pockets of highly developed plantation-type agriculture—sisal in Tanganyika, tea in the Nyasaland/Mozambique uplands, bananas in the Cameroons, rubber in Liberia, and so on. Between those extremes many other forms of agriculture can be categorised in which either the indigenous population or immigrant settlers have profited by good communications and set about growing remunerative export crops.

Twentieth-century agricultural developments are associated mainly with railway lines, largely because of Africa's lack of navigable rivers. The lines from Dakar to the upper Niger and from Kano to the coast carry groundnuts, cotton, palm oil. A far-flung web of rails occasionally supplemented by lake and river steamers is used to move maize, tobacco, tea and many other products from the Congo, Tanganyika, the Rhodesias and the Portuguese territories to the eastern, western and southern ports. There are two other specially important railways: the 'lunatic line' over the Kenya highlands, which carries tea, pyrethrum, sisal and coffee; and the Sudan railway linking the cotton lands of the Nile with the Red Sea.

**Indigenous Agriculture**

Africa's basic problems can be summed up by describing the situation in Ruanda-Urundi. The territory is at the hub of Africa, being the watershed between Congo and Nile. There is a high altitude region with forests, preservation of which is an important factor in the control of water resources. The central plateau with a predominantly temperate climate is densely cultivated, while the savannah country stretching eastwards is very subject to droughts.

The social structure in Ruanda-Urundi is somewhat complicated. The Bahutu, who are inclined to be cultivators (and constitute 84 per cent. of the population), dominate the small Batwa tribe ( one per cent.), but are themselves dominated by the pastoral Batutsi (15 per cent.). A traditional system of farming has become established in which the main crops are millets, maize, beans and sweet potatoes, with bananas and tobacco being grown in suitable places; but the system does not meet the needs of the people. Some of the reasons are: the initial poorness of most of the soils; depletion of soils by over-grazing, overcultivation and erosion; the conflicting interests of Batutsi graziers and Bahutu cultivators; and the susceptibility of the traditional farming system to drought, pests and diseases.

The Belgian administration's policy in Ruanda-Urundi has been along six lines. Agronomic research and experimentation are high on the list: scientific research at a more basic level is a longer term activity. Next come the technical and advisory services, agricultural and veterinary. Fourth point is the establishment of 'paysannats' (organised settlement or group farming schemes), consolidation of farm holdings, and organisation of special development areas. Specially organised processing and marketing facilities are required for the commercial development of certain crops;

and, finally, better training facilities are required not only for government technical assistants but also for some of the leading farmers.

The story of Ruanda-Urundi is the basic story in a nutshell of most of tropical Africa. Space does not permit a discussion of government policies, but, briefly: governments are conscious that industrial and national development follows the establishment of thriving agriculture; all governments accept responsibility for fostering improvements and conserving natural resources; agricultural co-operatives, marketing and settlement schemes are steadily increasing, with a definite trend towards mixed farming; and the plantation system is spreading, especially in the West African territories that are now self-governing. Most governments are keen to attract foreign capital for investment in agricultural development, but local land laws may prevent private investors from obtaining land.

### Cattle

In various parts of the continent the emphasis on the usefulness of cattle is differently placed—whether as meat, work animals, milk or manure producers; or even as a tally of the owner's wealth and position. Although tropical Africa has produced little meat on the world market, hides are an important export from several territories including Nigeria (13m. lb.) and East Africa (21m. lb.).

Experience has shown the danger of using temperate breeds for up-grading local stock; they just do not stand up to the climate. Practically no sign remains of past attempts to introduce European strains into West Africa, while in the East they are only to be found in the highland areas. It is now generally accepted that selective breeding of indigenous stock is the best way to improvement, although introduction from India to East Africa of sahiwal and red sindhi bulls, which are closely related to the established East African zebu, is expected to improve the milking qualities of local stock.

At present the general animal husbandry problem is to find means of feeding the stock adequately through droughts. Over most of the area cattle are close-herded, they enjoy only short grazing hours on poor pasturage and are more or less subject to pests, diseases and raids by wild animals.

Rinderpest is gradually being stamped out by vaccination. Tick-born diseases are controlled as effectively as possible in most territories by compulsory dipping. A much wider problem is posed by trypanosomiasis, spread primarily by the tsetse fly which is common in most of tropical Africa to the extent of eliminating cattle-keeping from vast areas. Progress is being made in tsetse fly control and the development of drugs which may eliminate the disease in infected animals. Foot-and-mouth disease is fairly common in at least three strains, but the effects are usually less serious in local stock than in European type animals.

### Crops

Virtually all tropical and temperate crop plants can be grown in one part or another of tropical Africa and its adjoining islands. Many of the crops grown extensively are to meet subsistence needs or to satisfy local trading opportunities; and there are several relatively small but locally important exports such as geranium oil from Reunion island and from the Kenya highlands; cashew nuts from Tanganyika; vanilla from Madagascar; lime fruit products from Ghana; and tung oil from Nyasaland.

Most of the world's cloves come from tiny Zanzibar and Pemba islands (182,000cwt. in 1958), while Madagascar is pressing for second place (120,000cwt.). Exports of ginger from Nigeria and Sierra Leone are equivalent to roughly a quarter of India's ginger exports. Africa is not an important coconut grower; she exports only about 125,000 tons of copra and nuts, mainly from Mozambique with small contributions from Tanganyika, Zanzibar, Madagascar, Togoland and elsewhere. Dispersal of coconuts down the east coast is thought to have been by Arabs who also seem to have introduced the mango. Attempts to grow jute substitutes such as kenaf with the idea of making sacks locally have met with little success in the face of competition from cheap raw material imported from India.

*Sugar.* Although Natal is an important sugar exporter the actual tropical belt of Africa does not figure largely in the trade. Most of the sugar produced is consumed locally, consumption being about 20lb. per head per year as compared with 65lb. in Western Europe. The islands of Mauritius and Reunion are, of course, important exporters.

SUGAR PRODUCTION
(*thousand tons*)

| | 1939/40 | 1959/60 (est.) |
|---|---|---|
| British East Africa | 60 | 140 |
| Mauritius | 250 | 571 |
| Reunion | 73 | 175 |
| Madagascar | 15 | 72 |
| Angola | 43 | 66 |
| Mozambique | 78 | 170 |
| Congo | 14 | 28 |
| Ethiopia | nil | 39 |

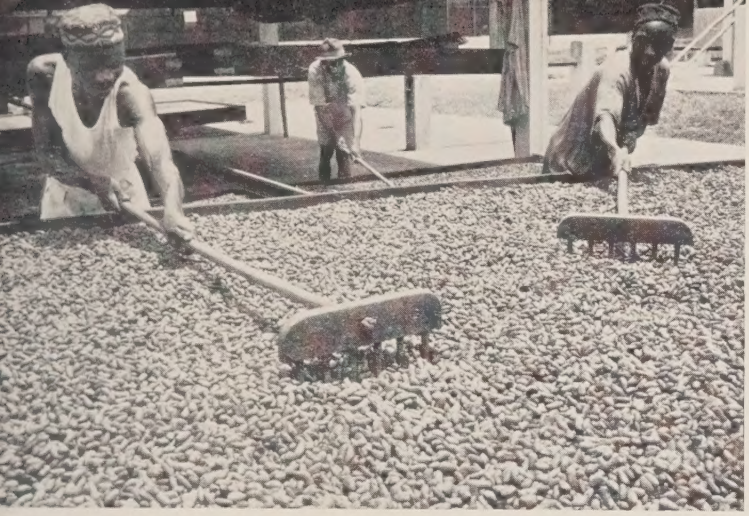
*Tea.* Africa has so improved her position as a tea grower that she is now ahead of Indonesia. Big expansions are going on in East Africa and the continent now produces seven per cent. of the western world's recorded tea.

TEA PRODUCTION
(*millions of lb.*)

| | 1959 |
|---|---|
| British East Africa and Nyasaland | 69 |
| Portuguese East Africa | 18 |
| Congo | 6 |

*Tobacco.* In a similar way, led by the Federation of Rhodesia and Nyasaland, Africa has gained an important position in the tobacco world. The Rhodesias now export over 100m. lb. of flue-cured tobacco annually and Nyasaland adds another 30m. lb. of fire cured leaf.

*Sisal and Kapok.* After false starts with several crops



*Spreading cacao beans over outdoor drying mats at the West African Cacao Research Institute at Tafo, Ghana.*

*Pyrethrum picking on a farm in Tanganyika. Grown mainly in the Kenya Highlands and Southern Highlands of Tanganyika, the crop is used for the preparation of a chemical extract which is mostly bought in New York for the manufacture of insecticides.*

*Bakiga boys in Uganda 'tying' graded tobacco leaves, before baling and despatching them for sale.*

*The famous long-horned cattle of Ruanda-Urundi.*

(including coffee, rubber, cocoa, oil palm) the early German agriculturalists in Tanganyika hit on what was to become the territory's staple agricultural export—sisal. The industry now produces half the western world's requirement and accounts for 25 per cent. of all Tanganyika's (and six per cent. of Kenya's) exports. Another fibre of very different quality is produced in substantial quantities from the middle belt of Africa: kapok falls from trees occurring naturally or planted, often to provide shade. British East Africa exports about 1,000 tons a year.

*Cotton.* Cotton floods out of tropical Africa at a rate exceeding two million bales (400lb.) a year. Second only to the Sudan, Uganda exported 400,000 bales in 1959 and the crop was 'not quite up to expectations'. Extension of the Sudan Gezira Board's operations over an additional 60,000 acres contributed to Sudan's bumper crop of 700,000 bales and three more similar expansions seem likely in future. The Congo, French Equatorial Africa and Mozambique are all cotton growers of increasing importance.

COTTON PRODUCTION
(*thousand bales of 400lb.*)

| | 1959 | |
|---|---|---|
| Sudan | 691 | |
| (Aden) | (19) | |
| Uganda | 401 | |
| Tanganyika | 201 | |
| Kenya | 17 | |
| Nyasaland | 16 | |
| Nigeria | 176 | |
| Other parts of tropical Africa | 500 | (approx.) |

*Coffee.* Tropical Africa exports both low-grown *robusta* and high-grown *arabica* coffee. An international coffee agreement of September last year limits exports on a quota basis and is expected to have a stabilising effect on *arabica* prices. Coffee production in the Congo and Angola has been rising rapidly; smaller increases have occurred in Sierra Leone and Nigeria, while there has been a slight decline elsewhere in West Africa.

COFFEE PRODUCTION
(*thousand cwt.*)

| | 1959 | |
|---|---|---|
| Uganda (mainly robusta) | 1,600 | |
| Tanganyika (mainly arabica) | 497 | |
| Kenya (mainly arabica) | 475 | |
| Other, Africa | 9,907 | |
| Other, World | 60,000 | (approx.) |

Prices paid for *arabica* coffee vary widely according to the quality of the crop and it is interesting to note in passing that African smallholders in Tanganyika have been getting prices averaging about 320-330s. a cwt. which compare well with the 350-360s. averaged by European growers operating on a much bigger scale.

*Cocoa.* Africa exports over 500,000 tons of cocoa beans each year, of which roughly two-thirds come from Ghana and Nigeria. World production was at a record level in 1959, especially in West Africa, and further increases are expected in 1960.

PRODUCTION OF RAW COCOA
(*thousands tons*)

| | 1948/49 | 1958/59 |
|---|---|---|
| Ghana | 278 | 255 |
| Nigeria | 109 | 140 |
| Ivory Coast | 50 | 55 |
| French Cameroons and Equatorial Africa | 51 | 62 |
| Spanish Guinea | 13 | 21 |
| San Thome and Principe | 7 | 7 |
| Togoland | 2 | 7 |
| Sierra Leone | 1 | 2 |
| Congo | 2 | 5 |
| Other, Africa | 1 | 1 |
| | 514 | 555 |

Ghana is heavily dependent on cocoa which is subject to wide price fluctuations over the years; she is increasing her timber exports; and she has made a modest start with rubber, production now being about 300 tons a year.

*Rubber.* American interests long ago established rubber as the mainstay of Liberia, and Nigeria is now following suit. By the late fifties production in Nigeria and Southern Cameroons was reported to be approaching 60m. lb.

*Oil palm.* The same part of Africa is the natural home of the oil palm and production is from both wild and cultivated palms. Plantations supplement the efforts of African farmers. The Congo's exports of palm products continue to increase in spite of political uncertainties[1]; oil production (at over 200,000 tons) was up 12 per cent. in 1959 and kernals (65,000 tons) were up five per cent. Nigeria exports over 700,000 tons of palm products each year.

*Groundnuts.* Groundnut production was fairly steady in 1959, a decline in French West Africa being balanced by an increase in Nigeria. The Sudan had a record year. India and China are the world's biggest groundnut growers; West Africa comes third, but is the most important in Western World trade.

* * *

Although it would be quite wrong to say tropical Africa is a vast storehouse of untapped fertility, scientific study and systematic development are now resulting in improved living for the inhabitants and a rapidly increasing flow of agricultural products to the world's markets. Indigenous farmers are increasingly benefiting by improvement schemes (which are not always popular at first); the future of European settlement hangs in the balance as political upheavals take place in emergent territories; but there seems to be little doubt that for certain crops (especially those requiring specialised processing or marketing) the plantation system has become thoroughly established.

[1]This article was written before the development of the Congo crisis.

# Land Reclamation in Holland

## bringing the polders into production

*The outer walls of the dyke, which are built first. Cranes lower the boulder clay into the water; this is reinforced by stones stuck on to willow mattresses. Sand is then pumped in to form the centre portion of the dyke.*

*A symposium of four papers and an introduction, by* **Professor D. Bakker, Dr. Ir. J. J. Jonker** *and* **Ir. H. Smits,** *Research Department, Zuider Zee Polders Development Authority, The Netherlands.*

In 1918 work started on the enclosure and partial reclamation of the Zuider Zee. Fourteen years later, in 1932, the Zuider Zee was enclosed, with the closure of the last gap in the surrounding dyke (or *Afsluitdijk*). At that point the name Zuider Zee was changed to IJsselmeer, and within a year and a half of its being enclosed the IJsselmeer became a freshwater lake.

The partial reclamation of the Zuider Zee is now well under way. Two polders totalling about 175,000 acres have been reclaimed, cultivated and colonised; the third polder, Eastern Flevoland, 135,000 acres in extent, was drained in 1957. One-third of this polder has since been cropped, but colonisation has yet to be started. Two more polders with a total area of 250,000 acres remain in the programme, and work has already started on the dykes for them.

A polder is a region in which the ground lies below sea level—usually 3ft.-15ft.; the water level in the canals has to be kept a further 3ft. 6in.-4ft. 6in. below that of the land. The water levels of the various IJsselmeer polders range from 13ft. 6in. to 19ft. below sea level, so it is obvious that any superfluous water has to be pumped out, as it cannot drain away.

When making a polder, a given area of water is surrounded with dykes and so turned into an artificial lake. Pumping stations are installed at various points to pump out the water after the dykes are closed. Canals and

*The Dutch polders*

ditches are then dug in the dried sea-bed, roads and bridges are built, and the land is made fit for cropping. Later, farms, houses, shops, schools and churches are built and water mains and electricity and telephone cables laid. Finally, suitable people have to be found to colonise the new polder.

Although a great deal of the actual work is done by contractors, the Government is entirely responsible for the polder schemes, which it both finances and supervises. The Government carries out all the initial agricultural work and continues to be responsible for farming the land for the first few years; leasing to individuals does not start for three to five years, by which time there remains little of the earlier risk of crop failure, and also houses and services have been provided.

A few of the many factors involved in bringing the polders into production are discussed in the four articles that follow.

*Polder Reclamation—1*

## Soils and Soil Mapping

Before it was enclosed in 1932, the Zuider Zee was a tidal inlet of the sea into which a number of rivers and streams flowed. Under normal conditions, the water was brackish or salt. The sediment which formed under these conditions thus consisted of marine deposits, which is still apparent from the microfauna and macrofauna remains. In the Netherlands, all marine deposits are calcareous and the Zuider Zee deposits are no exception; the calcium carbonate content is usually 8-10 per cent. and is only lower in the very light soils.

The marine origin of the sedimentary deposits means that a fairly large proportion of the cations adsorbed consist of sodium. As a result of chemical and physical processes, the sodium content undergoes radical alterations in the course of a few years after the water has gone.

One striking feature is that the high percentage of sodium does not give rise to unfavourable structures and of its own accord drops appreciably within a short space of time. This is accounted for by the presence of fairly large quantities of pyrites in the soil, the oxidation of which gives rise to iron sulphate, which hydrolyses to form sulphuric acid. This combines with the calcium carbonate in the soil to form gypsum, the calcium ions of which replace the sodium ions in the soil. The sodium ions occurring in solution in the soil are ultimately leached out of the ground by excess rain. So much gypsum is formed that for several years there is a saturated gypsum solution in the soil. This results in the structure remaining satisfactory during the transition process.

Silt from the Zuider Zee has settled out under water and the sedimentary deposits are consequently very loose in structure and of high porosity. Thus, during the first few decades after draining, a good structure can be achieved with little cultivation; on the other hand, during this period the soil may be overworked, with consequent loss of

structure. The original loose structure is being lost very slowly and the soil therefore becomes more and more compacted; this is accompanied by a reduction in depth of the soil horizons and a subsidence of the surface. The cultivation of the soil entails less hard work at the outset than that of a geologically older soil of similar clay content.

Another result of the accumulation of silt under water is that the composition of the soil hardly ever shows any great variation within limited areas. On the contrary, changes in composition are usually very gradual.

The loose structure of the sedimentary deposits is responsible for a very high water content at the time of draining. The drying-out, caused by atmospheric and plant-growth factors, is largely a non-reversible process, so that the cracks formed during drying out in summer only partially close again during the winter. Thus the cracks in the soil improve drainage conditions, which compare favourably with those of older soils in which the cracks formed in summer close again in winter.

In the virgin soil—i.e., before and at the time of draining—there is a direct relationship between the clay content on the one hand and the humus, potash, phosphate and water content on the other. This is shown by the figures in Table 1.

The virgin sedimentary deposits have never, of course,

*The banks of new waterways form soil profiles which can easily be mapped.*

*Drying out has resulted in marked cracking in the sub-soil.*

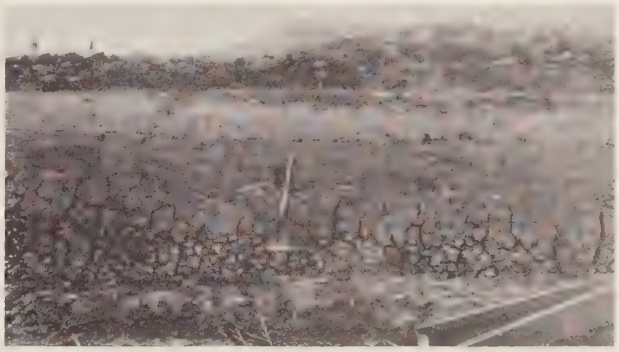


**Table 1. Relationship between clay content and water, humus, phosphate and potassium content; IJsselmeer polder soils before drainage.**

| *Code Number* | *Clay Content* (1) | *Average Clay Content* (1) | *Quantities present with average clay content* | | | |
|---|---|---|---|---|---|---|
| | | | *Water* (1) | *Humus* (1) | $P_2O_5$ (2) | $K_2O$ (3) |
| 0 | 0-1.5 | ±1 | 23 | 0.3 | 8 | 4 |
| 1 | 1.5-3 | ±2 | 26 | 0.4 | 10 | 6 |
| 2 | 3-5 | 4 | 31 | 0.6 | 12 | 12 |
| 3 | 5-8 | 6.5 | 38 | 0.9 | 15 | 19 |
| 5 | 8-12 | 10 | 48 | 1.3 | 19 | 30 |
| 6 | 12-17 | 14.5 | 60 | 1.7 | 24 | 44 |
| 7 | 17-25 | 21 | 78 | 2.2 | 31 | 63 |
| 8 | 25-35 | 30 | 103 | 2.7 | 42 | 90 |
| 9 | 35-50 | 42.5 | 143 | 4 | 56 | 126 |

(1) *In g. per 100g. dry material.*

(2) *In mg. per 100g. dry material, soluble in one per cent. citric acid.*

(3) *In mg. per 100g. dry material, soluble in 0.1 n. HCl.*

been exposed to the influences which cause soil to be formed. The new soil can therefore never be classified into illuvial and eluvial horizons. In practice the classification is based on the clay content, which means that it is at the same time based on the other values which are related to it (*see* Table 1).

The classification of the polder soils is given in Table 1 (first two columns), the code numbers from 0 to 9 representing the various clay contents. These references are used to indicate the soils on maps; the code numbers are a Dutch classification which does not correspond with the British and American classifications. Since the percentage of silt (i.e., particles of 2 to 50μ) is correlated with the clay content, a further sub-classification according to the silt content would be pointless. The same applies to the sand content.

**Soil Mapping**

The soil mapping of the area is carried out in several stages. The first charting, for which fishing vessels are used, is carried out some years before work is started on enclosing the polder. Bore-holes are drilled at the rate of one to every 100 acres. The first survey maps are used to draw up plans, for example to determine the lay-out of the dykes, so as to include as much good soil as possible inside the polder and exclude the poorer soil; to decide where to put the pumping stations and the main canals; to estimate the probable subsidence; and to establish the polder water level in the various parts of the polder.

After drainage, a more thorough investigation is carried out in areas with fairly varied soil conditions in order to ascertain whether any of the detailed plans of these areas need further modification. The difference between mapping what was formerly sea-bed and mapping older regions is that in the case of the new polders there is no help from the topography. As a rule, therefore, bore-holes are drilled according to a grid pattern.

Lastly, after the ditches and trenches have been dug, a final very detailed survey of the soil conditions is carried out. The banks of the new waterways form soil profiles which are quite easy to map. The detailed survey maps are used for such purposes as making fertiliser application recommendations, selecting trial plots, drawing up soil improvement proposals and determining rentals for the lease of the ground.

**Sub-Soil**

So far no mention has been made of the sub-soil. From the agricultural point of view, this is not significant provided it is not manifestly of poor quality—which, however, is the case here and there. For instance, there are sometimes non-marine strata in the sub-soil (peat, peat detritus and formations which have been deposited in fresh to slightly brackish water). In places, Pleistocene sands are found quite near the surface; generally, however, the top of the Pleistocene strata begins more than 3ft. down—usually 6ft.

**Table 2. Soil condition of the top soil of the IJsselmeer polders.**

| | *Total area in hectares* | *Comprising* | | | | |
|---|---|---|---|---|---|---|
| | | *Clay and Clay Loam* % (1) | *Loam* % (2) | *Sandy Loam* % (3) | *Sand* % (4) | *Peat and boulder clay* % |
| Wieringermeer Polder | 20,000 | 33 | 19 | 16 | 31 | 1 |
| North-Eastern Polder | 48,000 | 1 | 48 | 29 | 17 | 5 |
| Eastern Flevoland | 54,000 | 50 | 39 | 7 | 4 | 0 |
| Southern Flevoland | 42,000 | 86 | 12 | 0 | 2 | 0 |
| Markerwaard | 56,000 | 33 | 29 | 16 | 21 | 0 |
| Total | 220,000 | 41 | 29 | 14 | 15 | 1 |

(1) *Code numbers 8 and 9.* (2) *Code numbers 6 and 7.* (3) *Code numbers 3 and 5.* (4) *Code numbers 0, 1 and 2. See Table 1.*

or more. These divergences are indicated by special signs on the maps.

The soil condition of the top soil of the IJsselmeer polders is given in Table 2.

To sum up, it can be said that the greater part of the area of the IJsselmeer polders consists of very good soil on which arable farming can be carried out. On the remainder of the land, mixed farming has to be carried out.

*Polder Reclamation—2*

## Natural Vegetation

In the plant life which becomes established, apparently spontaneously, on the virgin soil of the IJsselmeer polders after the water has gone, plant species predominate which, once cultivation is started, may cause serious weed infestation among the crop plants. Other species occur which have little or no significance as weeds; some are even regarded as beneficial from the agricultural standpoint.

The establishment of the natural vegetation on the heavy, wet soil, which is often rich in nitrogen, cannot be prevented owing to the swamp conditions which initially exist, and because of its rapid and luxuriant growth. Once the natural vegetation has become established, it can sometimes be controlled by applying herbicides, but owing to the extensiveness of the area, this is only possible on a limited scale. Moreover, by that time, a number of weeds will have produced a considerable amount of seed, which may retain its viability until after the land has been made cultivable. In addition, no crop plant is known which is capable of suppressing the natural vegetation in the pioneer environment.

Before the soils are brought into cultivation, there are only two possible methods of weed control: either by preventing weed seed dissemination on the adjacent older land, or by establishing a harmless pioneer vegetation which will suppress weeds immediately after drainage.

It was found that the prevention of weed growth on the adjacent older land did not produce the desired result. While it is true that the pioneer vegetation results in part from the vegetation on the adjacent older area, the greater part of it comes from seeds deposited by the waters of the IJsselmeer before drainage; many of these seeds retain their viability for five to 10 years, or even longer. After drainage, initially the wind is the main carrier of weed seeds, and subsequently man. It was found that the seeds of several very noxious weed species are carried considerable distances, both by the wind—e.g., coltsfoot (*Tussilago farfara*)—and by man—e.g., creeping thistle (*Cirsium arvense*).

On the other hand, the sowing of a pioneer vegetation with little or no weed characteristics was found to be promising for large-scale application. It is now generally thought that before reclamation, vegetation of some kind or other is preferable to soil without vegetation. It is realised that plant growth accelerates the maturing of the soil, though the species which are preferable are those with little or no weed characteristics and which are capable of keeping down the harmful species.

Only a few weeks after the water has gone, seeds carried by the IJsselmeer water are already germinating on a large scale. The annual species with weed characteristics predominate, such as a persicaria species, *Polygonum nodosum*, and hastate orache, *Atriplex hastata*. As a result of the high humidity and considerable nitrogen content of the soil, they are extremely hardy, so that they produce seeds in billions, and these retain their viability for several years in the soil. If, after reclamation, these seeds end up in the top layer as a result of soil cultivation, they germinate and thereby cause serious weed infestation of the crops.

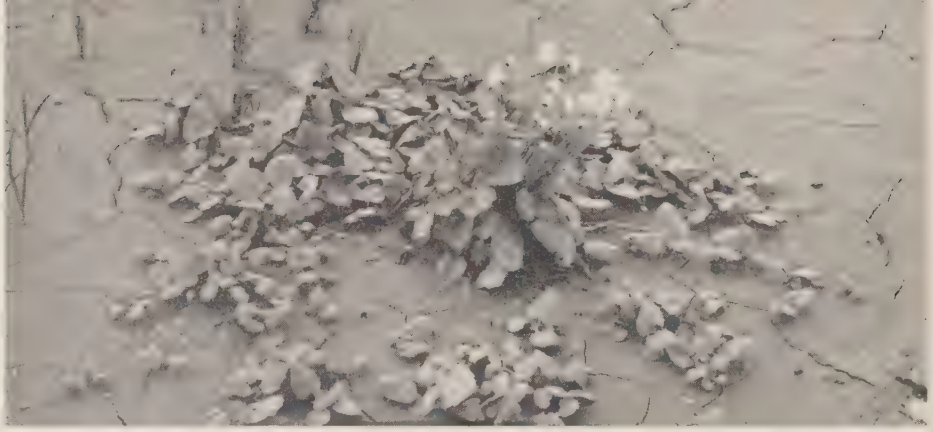
In the second year, biennial species start to become established (such as marsh fleawort, *Senecio congestus*, and sea aster, *Aster tripolium*), carried by the wind, which have no weed characteristics. When they are fully grown, they retard or prevent the growth of nearly all other plant species. The next generation, however, usually already shows a decline in vitality, probably due mainly to the exhaustion of the nitrogen in the soil. Other species, including a number of weeds, then have the opportunity to become established or to spread.

Even species which after establishment from seed reproduce asexually also, like reeds, *Phragmites communis*, sea club-rush, *Scirpus maritimus*, and coltsfoot, *Tussilago farfara*, although they are mainly established in the first year, represent a much larger proportion of the vegetation in the second year. Where growth is retarded by marsh fleawort or sea aster they do not begin to predominate until the third year. With the exception of the seepage pools where sea club-rush remains predominant, and the higher-lying sandy soils, which are rather dry in summer, reeds become commonly established.

### Reeds

The aggressive nature of reeds in a humid, fertile environment means that they can constitute the sole vegetation for several years; even coltsfoot and sea club-rush are stifled by them. For preventive weed control, therefore, reeds appeared significant, especially as they serve to improve considerably the maturing of the soil and ease of access to the area. Consequently, reeds now tend to be regarded as a beneficial plant from the agricultural point of view, at any rate on the IJsselmeer polders. The species declines in vitality eventually, so that weeds do establish, but the greater part of the reed-grown soil is already under cultivation before this stage is reached.

Reed seedlings are delicate and very susceptible to drought, as well as to competition with other species. In the second year, a tremendous spread of growth takes place, caused by long creeping runners. The less competition there is, the sooner the species becomes established in an area. Given suitable soil conditions, with no other vegetation present, reed seedlings, at the rate of 250 per acre, can form a dense growth within three years. If, however, there are other varieties depending on their composition and coverage, denser growth is needed in order to



*Coltsfoot*, Tussilago farfara, *established from a single seedling one year after drainage (Eastern Flevoland).*

*Well-developed pioneer growth of marsh fleawort*, Senecio congestus (*Eastern Flevoland*).

*This helicopter, a Colibri, is being used to sow reeds in Eastern Flevoland. Because they establish quickly, reeds are sown as a pioneer crop on newly reclaimed polders.*

*Sown reeds at the end of the first season's growth (Eastern Flevoland).*

predominate. In general, the sooner the reeds become established on a large scale after drainage, the better chance they have of rapidly becoming the sole vegetation.

In the light of this experience, during the first few years after the drainage of Eastern Flevoland, reeds were sown over about 87,000 acres on the third large IJsselmeer polder. It is already clear that this has provided a dense growth much more rapidly than if it had had to establish itself by natural means. Practical methods have been devised of encouraging reeds to spread after reclamation, chiefly by drainage and soil cultivation.

After reclamation, during the period of temporary exploitation by the Government, the scale of operations is vast and the choice of crops limited, owing to the extensive area cultivated and the still unfavourable soil conditions. During this period, weed infestation may gain ground rapidly. Much attention is now being paid to the use of herbicides, but the results, especially in the control of *Polygonum nodosum* and *Scirpus maritimus*, are invariably far from satisfactory; this again points to the importance of preventive control.

*A specially wide seed drill used for sowing reclaimed areas; it has a swath width of about 25ft. and a towing width of just over 6ft.*

*Polder Reclamation—3*

## Cropping and the use of Fertilisers

After the final drainage system has been completed, various crops can be grown on the land. A number of problems arise, however, in connection with the availability of labour, mechanisation and crop selection. A high degree of mechanisation may go a long way towards solving the labour shortage problem, but at the same time such mechanisation limits the choice of crops that can be grown. In addition, crops usually preferred are those which involve least risk as regards weather and plant pests and diseases. Other factors to be taken into account include the storage and marketing of the harvested crop, the spreading of work over the year, and the establishment of suitable rotations.

In the Wieringermeer, the North-Eastern polder and Eastern Flevoland, it was found that not all crops could be grown during the first few years after the water had gone. In the Wieringermeer, this was due to the presence of sodium chloride in the soil. In the other two polders, however, where this problem did not arise, it appeared that clovers and other leguminous crops could not be established during the first few years. This could not be overcome by inoculating the seed or the soil with *Rhizobium*.

In Eastern Flevoland, it was found that large quantities of phosphatic fertiliser (120-150lb./acre $P_2O_5$) were sufficient to achieve fairly normal development of red and white clovers, lucerne and peas. This applied especially to the places where there had been no vegetation before. After the growth of either natural vegetation or crop plants, some of the difficulties seem to have been partly overcome, as well as the need to apply large quantities of phosphatic fertiliser. In general, however, the growing of peas and beans is considered to be risky during the early years. Clover is more easily established.

Flax behaves very similarly. Although large quantities of phosphatic fertiliser may bring about slightly improved development, it has become clear that the soil must have been covered with vegetation for several years before difficulties cease to arise. Potatoes, also, do not appear to develop quite normally during the first few years.

Fortunately, winter colza and cereal crops do not present any particular problem, and they are capable of producing satisfactory yields from the outset. These are also the crops which offer the best prospects from the point of view of mechanisation, and require least attention.

Satisfactory crop rotation calls, of course, for a cropping programme which leaves enough time for preparing the soil between crops and allows harvesting to be staggered. These requirements are fulfilled by winter colza, wheat, barley and oats.

The position is less simple with regard to the weather and pests and diseases. Winter hardiness has to be taken into account, which is why winter barley is not grown. The late ripening of spring wheat likewise means that this crop cannot easily be grown.

The frequent growing of winter colza involves the necessity of controlling cabbage flea-beetle, *Psylliodes chrysocephala*, blossom beetle, *Meligethes aeneus*, and cabbage seed weevil, *Ceutorrynchus assimilis*. Control is comparatively simple, but is costly and takes time.

Crop rotation covering only cereal crops and winter colza increases the incidence of take-all disease, *Ophiobolus graminis*, which may cause crop failure. However, it appears that the severity of attack decreases as the years go by after the water has gone. Complete failure of winter wheat was a familiar feature of the North-East polder in the early years but has not been common recently; in Eastern Flevoland the trend has been similar. The growing of oats

*A first crop of winter wheat, grown on reclaimed polder soil.*

after wheat or barley considerably reduces the likelihood of attack by take-all. Unfortunately, though, this crop does not lend itself well to cutting with a combine harvester, as in the majority of varieties so far available the straw is too soft and straw and seed do not ripen simultaneously. The cultivation of clover as a stubble crop after cereals appears to reduce the incidence of take-all to some extent.

The usual crop rotation is winter colza, winter wheat, spring barley, oats. Lucerne can be undersown in winter wheat and spring barley, and can then be left standing for a whole year, harvested three or four times and dried. Yellow trefoil, *Medicago lupulina*, is often undersown in winter wheat and summer barley.

**Fertiliser Practice**

During the initial cropping period fertilisers are applied to the soil to provide the plants with the necessary nutrients, in so far as these are not present in the soil or are present in an unavailable form; and to maintain the existing supply of nutrients, so that the future users of the land do not have to apply excessive quantities of fertiliser.

The proportion of nutrients such as lime, phosphate and potash depends very much on the clay content of the soil. On the whole, the clay content (20-40 per cent.) ensures that the supply of nutrients is amply adequate. It should, therefore, only be necessary to use fertilisers to make up for the amounts of nutrients taken up from the soil. In the case of lime and potash, even this is unnecessary in view of the high content of these materials in the soil.

In the case of phosphate, however, such compensation is regarded as very necessary. Fertiliser recommendations for old arable land (outside the polders) are based on the phosphate content of the soil, determined by conventional methods; moreover, they are based on the particular requirements of each crop. On heavier soils, such as in Eastern Flevoland, according to the rules, a light fertiliser application should suffice, depending on the quantity to be replaced.

The availability of phosphate to the plant, however, changes as the soil matures. If, for instance, old and new soils with the same phosphate content are compared, it appears that during the first few years after drainage, clover and other legumes require a much heavier fertiliser application for establishment than is recommended for old arable land. During the next stage, fertiliser can be applied at a lower rate than is recommended for all crops on old arable land. Subsequently, fertiliser must be applied according to the recommendations. This implies that in view of the gradual physical maturing of the soil (including drying out), phosphate availability is greater at the outset than it is later on.

Much investigation is required in the application of nitrogenous fertilisers. While the natural vegetation is in sole possession, the initial high to fairly high natural nitrogen content of the soil drops steeply. This means that unless leguminous plants for green manuring are grown, the nitrogen supply throughout the soil is very low after the land has been put into cultivation. The greater part of the nitrogen to be absorbed by the plant must, therefore, be provided in the form of fertiliser. Since, when a combine harvester is to be used, cereal crops must not become lodged, the fertiliser must not be applied too heavily. On the other hand, an inadequate application of fertiliser is equally unsatisfactory on account of the poor yield.

Both the quantity of nitrogenous fertiliser and the period of application affect the crop yield. At some stages in the development of grain crops the straw ceases to react much, if at all, when a nitrogenous fertiliser is applied, though the developing grains of wheat are by then quite capable of reacting. It is therefore possible to apply nitrogen in such a way that a high grain yield is maintained while the straw yield is kept as low as possible. This is especially important in the case of varieties of cereals whose only drawback is over-abundant or unduly soft straw.

*Polder Reclamation—4*

## Animal and Insect Pests

It is not only the flora but also the fauna which appear that require continuous attention after drainage of the polder. Even before any crops are grown, various harmful animals multiply so rapidly that they acquire a nuisance value for the first settlers or cause damage to subsequent crops.

The occurrence of these pests was ascribed until recently to the absence of the 'balance of nature', which was supposed to account for the high population densities of harmful species. This vague theory shows that there was no real knowledge of the ways in which these harmful species can develop into plagues. Although little is known about it even now, it has become clear in recent years that significant factors may include the existence of large areas of wet, soft soil, surplus food supplies and the presence of

extensive areas of a particular vegetation pattern. Presumably, too, in some cases at any rate, the fact that there are few natural enemies of the harmful species may be significant. In addition, when the soils are cropped conditions for the animals become even more favourable, and the population density gradually increases. These various pest trends in the IJsselmeer polders can be illustrated as follows.

The mosquito, *Culicoides salinarius*, is a notorious pest remaining from the period when the natural vegetation was in sole possession. During the first few years after drainage this insect may be present in millions during warm weather and can cause skin irritation which may have unpleasant or even serious side-effects. Since the mosquito occurs in many swamps outside the polders, it is unlikely that its large-scale occurrence on the new polders is due to the absence of natural enemies. As far as its life-cycle is concerned, *Culicoides* requires soft, very wet soils, in which the egg develops into the larva. Thus, it is mainly the type of soil and its area which determines whether or not this insect can complete its life-cycle on a large scale.

The obvious conclusion is that the most effective method of controlling *Culicoides* is to drain the swamps. In the long run, the natural vegetation draws so much moisture from the top layer of soil that the environment becomes unfavourable for the development of this insect. Before this stage is reached, however, *Culicoides* may be a nuisance for several years. Consequently, in the spring of 1959, a stretch of marshland about 500 yards wide around Lelystad, where the population had suffered seriously from this mosquito in 1958, was drained and sprayed with dieldrin wettable powder, with satisfactory results. Such control cannot, however, be carried out on a large scale, owing to the extensive and inaccessible nature of the ground.

**Brown Rat**

The brown rat, *Rattus norvegicus*, follows close on the heels of man. The species is consequently already present in large numbers at the time when the dykes are being constructed, when the camps and stores provide ample supplies of food; it also spreads rapidly through the natural vegetation. On high-lying ground, such as banks and dykes, these rats burrow their tunnel systems. In wet areas, *Rattus norvegicus* also builds nests above ground. In the spring and summer, it lives largely on the eggs and young of birds nesting on the ground, such as terns and sea-gulls; and in the autumn and winter it lives on the starchy rhizomes of reeds and sea club-rush, though at this season, too, migrating birds (which cluster on the polders in hundreds of thousands)—and especially those that are sick or wounded —are preyed upon by rats. Even after cultivation has been started the brown rat may cause damage.

Control of the brown rat is not possible before reclamation, but afterwards the species can be suppressed locally by laying bait mixed with coumarone. This is placed strategically in boxes, so that other species of animals will not be poisoned.

The continental vole, *Microtus arvalis*, is regarded as one of the most harmful species of animal to agriculture during the reclamation period. Some areas have long been known in the Netherlands where plagues of voles often occur every three to five years. Generally speaking, these areas are stretches of extensive grazing land, where the vegetation is short and rough with few natural enemies before the plagues occur. After the soil has been drained, shrubs start to grow on the dykes and higher-lying ground on the polders which appear to be favourable for the development of plagues of continental voles.

Even in the early period after the land has been put under cultivation, the species may increase considerably owing to extensive cultivation of cereals and legumes in fields intersected by ditches overgrown with weeds. As soon as the land is leased to farmers and intensive cropping is carried on, the plagues of voles disappear. Apparently these plagues are mainly associated with a particular vegetation pattern. However, after the agriculture has been intensified, the available food supplies are not reduced, and the number of natural enemies decreases. There is therefore no clear picture of the population density pattern of the continental vole.

**Vole Control**

During the reclamation period *Microtus arvalis* may cause serious damage to crops and young trees. As the vole migrates from adjacent land to the polders, and the new dykes of the existing polders are only linked with the adjoining areas by a few bridges, attempts are now being made to stem the invasion by means of poisoned bait barriers. Poisoned bait is also placed in holes. In addition, the number of natural enemies is being increased by providing artificial nesting sites for kestrels (*Falco tinnunculus*) and owls (*Tyto alba; Asio otus*). Large-scale spraying with highly toxic rodenticides cannot be considered owing to the risk to other fauna, since in the first stage the polders are an important sanctuary for many protected birds.

The cabbage seed weevil, *Ceutorrhynchus assimilis*, on winter colza is an example of a pest which develops gradually after cultivation of the land has begun. Winter colza plays an important part in the crop rotation during the early cultivation of the polders, and is often sown as the first crop. At the outset, the cabbage seed weevil is not very widespread but, after a few years, this insect may multiply so rapidly that drastic control measures are necessary. The invasion clearly originates chiefly from the adjacent older land, as the damage first occurs mainly among the colza growing along the edge of the area. The cabbage seed weevil hibernates in the larval phase in the top layer of well-aerated soils in fairly sheltered positions, preferably in wooden fences and on the edges of woods, but also on the sides of ditches overgrown with weeds. So the invading weevils start to multiply on the polders once the environment has become suitable for them. Control measures must be undertaken from the very outset, even where there is no serious damage.

The largest weevil colonies are usually encountered at the edges of large colza fields, into which the insects migrate from their hibernation habitat, and it is often sufficient to carry out control on the marginal strips. Dieldrin, especially applied from the air, has been found to be a suitable insecticide for restricting the cabbage seed weevil population while the soil is being prepared for cultivation.

# COLONIAL PESTICIDES RESEARCH UNIT

*This account of the work of the Colonial Pesticides Research Unit, Arusha, is one of a series of articles on important agricultural research stations in different parts of the world. The work at Arusha is of particular interest in that it is concerned not only with pest problems of tropical agriculture but also with the control of insect vectors of human and animal diseases.*

*Previous articles in this series have described work at Rothamsted, England* (Span, **2,** 1)*; Wageningen, Holland* (Span, **2,** 3) *and Beltsville, USA* (Span, **3,** 1). *Accounts of other research stations will appear from time to time.*

In the shadow of Mount Meru (14,979ft.), on 25 acres of Mringa Estate, eight miles from Arusha, a collection of single-storey laboratories houses the Colonial Pesticides Research Unit.

This Unit was originally a small team which, under Mr. C. B. Symes, was sent out by the Colonial Office in 1945 to Entebbe, Uganda, to investigate the application of the new synthetic insecticides to the control of tropical insect pests. It concentrated for the first few years on mosquitoes and tsetse flies and these are still important lines of work.

In 1950 the headquarters moved to Arusha. The borrowed accommodation at Entebbe was required, and Arusha, being centrally placed in East Africa and with good communications and a pleasant climate, was considered the best choice of location.

A separate Agricultural Insecticide Research Unit was formed at Ilonga in 1954 but it was amalgamated with the present Unit at Arusha in 1956. Work on arboricides started in 1953, at first with the control of tsetse flies in view, but very soon the agricultural and veterinary aspects —control of weeds in crops and scrub in pasture—became of major importance. Work on fungicides started in 1956 and the name of the Unit was then changed from Colonial Insecticides Research Unit to Colonial Pesticides Research Unit. In 1958 the fungicides section was detached to work in Nigeria.

Work on molluscicides for the control of snails which are vectors of bilharziasis has recently been added to the commitments of the Unit, so that there is now a team with 30 European officers including 14 scientists—entomologists, chemists, physicists, botanists and plant pathologists—and a total strength of about 150. The Unit is at present administered by the Tanganyika Government but is financed entirely from Colonial Development and Welfare funds.

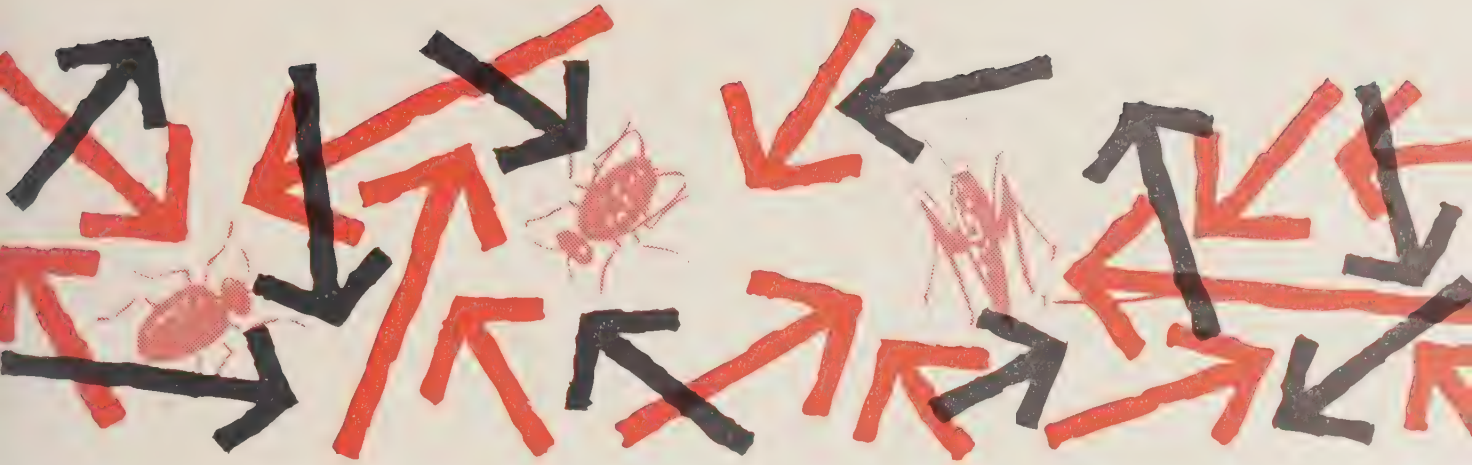
The terms of reference are that the team should work on the fundamental aspects of pesticide application and behaviour in relation to the control of tropical pests. This can be done scientifically only if all the specialists concerned can work as a team on the problems involved, and this Unit is the only organisation in the Colonies where this can be done. Many problems are investigated in cooperation with Territorial departmental scientists and if a practical method or technique is evolved, either by the Unit alone or in cooperation, it is applied to field control by the department concerned.

## TSETSE FLIES

To deal with species which live in a restricted habitat, such as *Glossina palpalis*, the most successful line of approach has been by vegetation spraying. At first, experiments were carried out to discover what type of formulation was most suitable. It was found that oil solutions were rapidly absorbed into the vegetation, and water suspensions were easily washed off by rain, so that emulsions were therefore the best type of formulation for a residual effect on vegetation.

The information available on *G. palpalis* suggested that hungry flies of this species search for food almost entirely at the water's edge and therefore that keeping the water's edge vegetation lethal to the flies for long enough would eradicate a population.

Experiments carried out on this basis with DDT in Kenya in cooperation with Dr. S. G. Wilson, of the Kenya Veterinary Department, proved completely successful. This method was then adopted by Kenya as a routine method of control of *G. palpalis* and proved very much



## ARUSHA, TANGANYIKA

*by* **K. S. Hocking,** *Officer in Charge.*

cheaper than clearing. However, the Unit continued its investigations and was later able to show that a change of insecticide from DDT to dieldrin made the method cheaper and more effective, and this change has now been adopted by both Kenya and Uganda. Uganda has recently destroyed a sleeping sickness epidemic over 400 square miles by this method and Kenya is in the process of eradicating *G. palpalis* from the whole of the Nyanza Province.

The widespread savannah species of tsetse flies (e.g., *G. morsitans*) cannot be dealt with so easily. An obvious way of tackling the very large areas involved is by the use of aircraft to apply the insecticide. Experimental work is difficult because it cannot be done on a small scale or in a short time owing to the scattered existence of these species of tsetse (they are dependent on very mobile game) and their long life history, a month or more of which is spent underground. Each experiment has to be carried out over several square miles and for six months or more.

The cheapest effective method that the Unit has been able to evolve costs altogether, if a light aircraft is used, about £350 per square mile. It consists of eight monthly applications of a $2\frac{1}{2}$ per cent. solution of dieldrin in oil, as a coarse aerosol at a pint per acre.

### Discriminative Bush Clearing

An alternative way of using insecticide against such a widespread insect is to find some method of limiting the places to which the insecticide is applied. Discriminative bush clearing has for many years been a standard method of tsetse control with some successes to its credit. Only recently, however, have studies by the East African Trypanosomiasis Research Organisation, at Shinyanga, on the resting sites and water and fat loss of tsetse flies produced a reasonable explanation of the method, and shown that it is unlikely to be successful unless the area concerned has a severe dry season. The method consists in cutting out the trees that provide the favoured resting sites and hence forcing the flies to rest in less favourable places; this reduces their chance of feeding and increases their rate of water loss and, with a severe dry season, is sufficient eventually to eliminate the population.

In milder areas, the fly numbers may be reduced, but eradication is not attained and it was thought that the application of a long lasting insecticide to the favoured resting sites might be a better method of attack on these milder areas. Throughout 16 square miles of *G. morsitans* habitat in the Kabiganda valley in Ankole, Uganda, dieldrin emulsion was applied to the trunks and undersides of horizontal branches of one species of tree (*Acacia gerrardii*). An average of five trees per acre were treated at a cost of about £250 per square mile, and this was sufficient almost to eliminate the fly population, despite possible infiltration. The Uganda Government are now anxious to apply this method to 100 square miles in Ankole where at present they are endeavouring to eradicate tsetse by game destruction.

### MOSQUITO CONTROL

Most of the Unit's work on the control of mosquitoes has been concerned with the treatment of houses with residual insecticides, as this seems the best way of taking advantage of the great persistence of these synthetic materials.

The application of insecticides to mud walls, which are the commonest surfaces in African houses, has posed many problems. This is due firstly to porosity: oil solutions as originally used soaked straight in and practically no insecticide was left on the surface. Laboratory trials with mud blocks showed that the use of a water suspension of a dispersible powder solved this problem; the insecticide was filtered off on the surface. It was then found that some muds exerted a strong physical attraction on the insecticide and it was drawn within the block and lost to the surface.

With some of the more volatile insecticides, such as BHC, this is an advantage, because it slows down the loss by volatilisation. However, with the almost non-volatile insecticides, such as DDT and dieldrin, there is practically no kill of mosquitoes on the surface after sorbtion has taken place. This worried laboratory workers and manufacturers for a long time and new formulations were made

to overcome the problem. In practice it never appeared to be a very serious problem, and it is now clear that because of the mixtures used in mud walls, and the high humidity in African houses, sorbtion is a slow and irregular process in the field and all that is necessary to compensate for it is a higher dosage of insecticide. This may not be the case, however, if organophosphorus insecticides are used for malaria control.

### Hut Trials

The problems of dosage and choice of insecticide against adult malaria vectors, particularly *Anopheles gambiae*, have been investigated by the Unit in a long series of trials in experimental huts. The huts are designed to be as like African houses as possible so that the behaviour of mosquitoes in the hut and emerging from it can be studied. From these experiments the insecticide and dosage to use in the Taveta/Pare malaria control scheme were decided and the results from that scheme confirmed the conclusions of the small experiments. A further series of experiments are now being undertaken to test insecticides which may be used against mosquitoes which are resistant to DDT, BHC and dieldrin.

The Unit is also directly investigating this question of resistance of insects to insecticides. Despite the fact that almost complete resistance of *A. gambiae* to dieldrin developed in Northern Nigeria, no sign of this appeared in the Taveta/Pare malaria control scheme—in fact no sign of resistance, or even reduced susceptibility, has been found in *A. gambiae* anywhere in East Africa. The CPRU has an entomologist testing in all likely spots from time to time. It appears possible that the resistant gene in *A. gambiae* is not present over the east side of Africa, although it is common on the west side. In the Taveta/Pare area, however, non-malarious mosquitoes, bed bugs and lice did become resistant to dieldrin.

## AGRICULTURE

It is felt that the Unit should deal with two particular kinds of agricultural problem. The major one is the investigation of spraying techniques on a particular type of crop (for example, bush crops such as coffee). This entails estimating the relationships between the physical and chemical assessments of the performances of different spraying machines, and of different methods of application (which include where the insecticide goes and how long it stays there), and the biological effectiveness of the machine and method of application, as measured by the degree of control of different pests obtained in the field.

This relationship is obviously quite different when dealing with a comparatively static insect pest such as a leaf miner, or with a fungal disease, from that found when dealing with a mobile insect such as *Antestia*. We have already shown that, with a static pest, the kill obtained depends at least as much on the variability of the insecticide deposits as on the actual average level of deposit.

It is hoped eventually to be able to define the type of application that is best for the control of any particular pest, and hence to be in a position to use physical assessments in place of long drawn out and expensive field replicated trials. This work will later be extended to methods of spraying ground crops such as pyrethrum and beans.

*General view of the Colonial Pesticides Research Unit, Arusha.*

### Particular Pest Problems

The second type of work, less general and fundamental, is to study a particular pest of a particular crop as an example of how pest problems can be investigated. We are, for instance, at present studying the control of *Pseudotheraptus wayi*, a sucking bug which is a pest of coconuts. One of the problems with pests of this kind is to know how important it is. One can see that very many young coconuts fall off the palms because they have been sucked by the bug, but it does not necessarily follow that the final crop of coconuts is any smaller because of this. The first step, therefore, is to obtain evidence on relation between insect damage and final crop; this we are doing by keeping an area of about 50 acres of coconut palms near Tanga free of the bug by lavish aerial spraying, and comparing it with a similar area in which the bug flourishes. We are also doing the same thing on small groups of palms to study the process in detail. As the coconut crop takes about a year to mature, the experiments have to continue for at least two years.

In the meantime in Zanzibar we are breeding *P. wayi* in the laboratory and testing to see what doses of which insecticides are most effective. We are also trying out various air-spraying techniques—comparing, for example, spraying small quantities of liquid as aerosols (which need repeating and are very dependent on good weather conditions) with larger quantities of liquid as coarser sprays for residual effect (when one aircraft load covers only a small area but

*CPRU African staff outside a field laboratory at Muguga. In the background are rest huts.*

spraying can be done under more adverse conditions). In connection with these experiments we are also studying persistence and distribution of the insecticides from different methods of application.

### ARBORICIDES

Our work on arboricides was initially intended to find out whether one could control tsetse flies by removing the evergreen cover on which they were dependent. It was found that the main difficulties in this arose from the different reactions to the arboricides of the different plants in the bush. Some dropped their leaves at once and then refoliated; some dropped them slowly and remained leafless for a long time; others, such as succulents, did not drop their leaves but eventually died. This meant that there was never any time after an application of arboricide when the bush was completely leafless. This difficulty could be overcome by making several applications but the method would then be impossibly expensive. The most fruitful field of use of arboricides in tsetse control would seem to be in preventing regeneration after mechanical clearing of bush.

The CPRU's work in this field may be divided into two parts. The more fundamental part, which is only just getting under way, includes pot trials on species susceptibility, investigations into the persistence of herbicides in soil under tropical conditions, and methods of assessment of herbicides in plant roots and soil leachates.

The other aspect of the Unit's work consists largely of liaison with other workers in East and Central Africa and the organisation of field trials in conjunction with these workers. The trials have included work on weeds in coffee, beans, cotton, maize, pyrethrum and grassland as well as on water weeds.

### MOLLUSCICIDES

Work on molluscicides has now started and experiments have been carried out in cooperation with the Division of Insect Borne Diseases of the Kenya Ministry of Health. Very promising results have been obtained with a new German compound both in a small scale trial and in a large irrigation scheme. These experiments have invoved the development of special equipment suitable for the accurate dispensing of small quantities of molluscicide suspension over a period of several hours.

Future work in this field, in cooperation with the World Health Organisation, will include attempts to improve methods of assessment of snail populations, as well as trials of the German compound and any other promising molluscicides at the lowest possible dosages which are effective under the varying conditions found in tropical Africa.

* * *

These examples of some of the problems which the Unit is tackling will indicate how such an organisation can help in the overall task of controlling pests in the tropics. By approaching the problems from the points of view of the biologist, the chemist, the physicist and the engineer one is able to obtain some inkling of the 'how' and 'when' in control methods instead of a plain 'what', and hence eventually to find the most effective and economical methods.

*Messrs. N. G. Khoroshajlov, Plant Industry Research Institute, Leningrad; S. S. Shain, Fodder Research Institute, Lugovaja, Moscow; G. Fajdiga and V. Sadar, both of University of Ljubijana, Yugoslavia; V. P. Meljnichuk, Fodder Research Institute, Lugovaja, Moscow; Miss B. Hughes, Shell Chemical Company, London; and Mr. O. Krstić, National Institute of Agricultural Botany, Yugoslavia.*

# International Grassland Congress

Some 50 countries were represented by over 700 delegates at the 8th International Grassland Congress when it was held in the UK (at Reading) in July this year. During the course of the Congress over 100 papers were read. These covered herbage plant breeding, grazing intake, herbage physiology and biochemistry, mineral nutrition of herbage, digestibility, silage techniques, grazing and pasture management, seed production, plant disease and nutritional disorders in livestock. Whilst many of the papers were, perhaps, of greater interest to the research worker than to the farmer, some valuable contributions were made on the subject of increasing livestock production from grass. In this connection it was stressed that the measurement of the digestibility of herbage is of great importance since small changes in the apparent digestibility can have far-reaching effects in terms of animal production.

A group of research workers at the Grassland Research Institute, Hurley, compared the digestibility of herbages cut from early and late types of rye-grass and S.37 cocksfoot. As a result of their work the authors suggested that, hitherto, over-much emphasis has been placed on the nutritional value of the leaf since growing stems have a digestibility at least as high as leaf. A silage of high feeding value can be profitably made by cutting at the ear-emergence stage.

The controversy regarding the respective merits of grass clover swards as opposed to nitrogen-fertilised pure grass swards received much attention. However, the evidence presented was so conflicting that no single recommendation could be applied to all circumstances.

The subject of tropical pastures attracted considerable interest and much attention was devoted to the choice of legumes suitable for growing in tropical areas. From the research results submitted by Dr. Griffith Davies, C.S.I.R.O., Australia, it is evident that grassland development in the tropics is becoming a subject of the greatest agricultural importance. In fact, this was the first international grassland congress at which a complete session was devoted to tropical pastures.

Many of the papers stressed the choice that must be made between maximum milk or beef output per acre of grass or the maximum per animal. To make the best use of the available herbage many schemes of rotational grazing have been postulated. The utility of many of these was questioned by Dr. C. P. McMeekan, Ruakura, New Zealand. He pointed out that in 15 separate studies rotational grazing proved, if anything, slightly inferior to set stocking.

In his opening paper Dr. William Davies, Director of the Grassland Research Institute, Hurley, had drawn attention to the under-exploitation of much of the grass in Britain. In his opinion grassland in the UK could profitably use as much as 800,000 tons of pure nitrogen per annum, whereas the present use of nitrogen in the UK on all crops including grass only amounts to some 350,000 tons N. The underdevelopment of much of our grassland was also referred to by Dr. H. L. Baker (Hurley) who stressed that much of the grassland in Britain is of poor quality and that full exploitation will only be possible if the botanical composition of the sward is markedly improved.

During the course of the Congress a number of technical visits and receptions were arranged. Included in the latter was a film show and reception given by Shell Chemical Company (UK) at which the accompanying pictures were taken.

Note: All names read left to right except where otherwise stated.

*Messrs. E. D. McDonald, Shell International Chemical Company, London, and J. Barisson Vilarez, Department of Animal Production, Brazil.*

*Messrs. F. M. Willhite, United States Department of Agriculture, Colorado; H. W. Ream, US Embassy, Taiwan; and G. S. Robinson, Massey Agricultural College, New Zealand.*

*Professor A. Pedersen, Landbrugets Plantecultur, Copenhagen; Mr. A. R. Beddows, Welsh Plant Breeding Station, Aberystwyth; Professor N. R. Nilsson, Microbiological Institute, Uppsala.*

*Professor G. Julen, FAO; Dr. D. C. Smith, University of Wisconsin; Dr. H. O. Graumann, United States Department of Agriculture, Beltsville; Mr. F. E. T. Suckling, DSIR, New Zealand; Mr. R. E. Wagner, American Potash Institute, Washington; Dr. P. C. Barclay, DSIR, New Zealand; Messrs. A. Johnson, Sulphide Corporation, Boolaroo, New South Wales; W. K. Kennedy, New York State College of Agriculture, Cornell University; J. S. Pulsford, A.C.F. & Shirley's Fertilisers, Brisbane; C. E. M. Tidmarsh, Department of Agriculture, Pretoria; and I. L. Elliott, Rukuhia Soil Research Station, New Zealand.*

*Dr. J. Melville, Waite Institute, Adelaide; Professor M. McG. Cooper, University of Durham; Mr. & Mrs. T. H. Turney, Northamptonshire; and Mr. J. L. Hunt, Shell Chemical Company, London.*

*Messrs. J. A. Richards* (left), *and M. S. Motta* (right), *both of Grove Place Agricultural Station, Jamaica, with Mr. F. E. Alder, Grassland Research Institute, Hurley.*

*Mr. G. Evans, Welsh Plant Breeding Station, Aberystwyth; Dr. J. Melville, Waite Institute, Adelaide; Professor H. G. Saunders, Ministry of Agriculture, London (chairman of the congress); Dr. C. P. McMeekan, Ruakura, New Zealand; Dr. William Davies, Grassland Research Institute, Hurley; and Mr. A. Jäntti, Finland.*

*Messrs. F. H. Garner, Royal Agricultural College, Cirencester; N. A. Iliff and H. G. Huckle, Managing Director, and General Manager, Agricultural Division, respectively, of Shell Chemical Company, London.*

*The Mayor and Mayoress of Reading, Alderman and Mrs. C. R. Evans, with Mr. and Mrs. A. A. Babiker, from the Sudan.*

*Professor W. T. Ewen, Ontario Agricultural College* (right) *and Mrs. Ewen, with Dr. C. E. Wright, Plant Breeding Station, Loughall, N. Ireland.*

# Chemical Ploughing in New Zealand

*by* **L. J. Matthews,** *New Zealand Department of Agriculture.*

*Are weedkillers capable of meeting the two primary functions of cultivation, those of reducing inter plant competition and preparing a seed bed? Detailed experimental work conducted by the Farm Advisory Division of the New Zealand Department of Agriculture over the past six years indicates that pastures and crops may be established without cultivation, and that greater flexibility is introduced into farm management practices. The following article is based on a review of over 300 trials.*

Although New Zealand is a country which largely depends on its agricultural economy, only one-third of the so-called agricultural land is capable of being developed by mechanical means, either by ploughing or giant discing. The alternatives that are adopted to increase the carrying capacity are aerial top-dressing, oversowing of clovers, pelleting of seed and closer sub-division. None of these methods, however, has proved so successful as the use of chemicals for pasture improvement.

With this method, one or more chemicals are used to destroy the existing vegetation, and seed is then either oversown or overdrilled into the dead turf. The results obtained, if all factors that contribute to the success of the method are considered, are equal to, or better than, those obtained by conventional methods of cultivation, overdrilling, etc.

## COMPARISON OF VARIOUS METHODS OF ESTABLISHMENT

### Normal Oversowing

In the absence of inter plant competition clovers usually establish satisfactorily, but in areas where such competition is severe (e.g., dominant browntop, *Agrostis tenuis*, Chewings Fescue, *Festuca rubra* var. *fallax*), the oversowing of clovers is not nearly so successful. Small seeded white clover usually establishes better than large seeded red and subterranean clover. The oversowing of high producing grasses in low fertility areas is rarely successful in the presence of inter plant competition. By prior destruction of the undesirable species, high producing strains of grasses and clovers can be successfully oversown.

A practice which has become established in New Zealand has been to top-dress hill country with or without oversowing. Over four million acres were so treated in New Zealand in 1958. Provided the manurial requirements of a particular soil type have been met, the usual effect of top-dressing is an increase in clover content (not necessarily high producing strains) but little change in the percentage of high producing grasses. The production of such a sward increases initially with an increase in clover but its potential production is not reached because of the absence of high producing species. Even where high rates of fertiliser are employed the content of high producing grasses does not increase materially. However, where the basis of a good pasture exists the application of fertiliser and management leads to a high producing pasture.

### Overdrilling

Overdrilling follows the same pattern as oversowing. In the absence of inter plant competition it is successful. In the presence of such competition even quick establishing species such as the ryegrasses fail to establish. Where inter plant competition has been removed with chemicals, overdrilling is successful. Clovers and grasses, even slow establishing species such as cocksfoot, have established well. Light rates of chemicals may be employed to purge the pasture of low producing species, at the same time checking the undesirable species. Under these conditions a light

seeding rate is sufficient to restore the productivity of the pasture.

### Cultivation

Where direct comparisons have been made, pasture establishment has been found to be slower by the chemical method than it is by cultivation; and usually the sward produced is not so pure as by cultivation, vestiges of the original sward generally remaining in the chemically established areas. The sward establishes free of weeds except for surface germinating species such as thistles and barley grass, *Hordeum murinum*. The long-term result is probably in favour of chemical establishment, as a nitrogen and phosphate inbalance does not occur to the same extent as in establishment by cultivation.

## FACTORS AFFECTING EFFICIENCY OF THE CHEMICAL METHOD

### Suitable Chemicals

The basic chemical used to destroy vegetation is a selective grass killer, preferably with no residual effects in the soil. Dalapon is the most effective chemical available to date. At rates up to 5 lb. per acre it controls most of the inferior grasses without seriously affecting high producing species such as the ryegrasses and cocksfoot. Its chief drawback is its residual effect in the soil, particularly to establishing legumes. Preliminary data suggest that the ester of dalapon is more suitable than the sodium salt. If non-grass weeds are present to any great extent it becomes necessary to apply another chemical to control them: the addition of 1 lb. amitrol per acre has the effect of reducing the competitive effect of grasses more quickly (though the final kill is no better), killing most flat weeds and checking existing clover. Again, residual effects have been encountered with this material and American work suggests that cacodylic acid may be a suitable substitute.

### Litter

The importance of dead litter, which forms the seed bed, cannot be overstressed. Where rainfall is adequate sowing can be made on ground that is virtually devoid of litter, but where this is not so, there should be sufficient litter to protect the seedlings from desiccation or frost, i.e., to establish a favourable micro-climate around the germinating seed.

It may be essential in some cases to allow several inches of litter to form by keeping the area closed from stock. If litter is excessive or organic turnovers low, as on low fertility soils, a period of decomposition is necessary. Under conditions of high fertility the rate of decomposition of litter is rapid and unless replacement is quick, surface germinating weeds strike. Litter also prevents the establishment of partially destroyed grasses and weeds.

### Period Between Spraying and Oversowing

There are two interdependent factors to be taken into account in determining the interval between spraying and oversowing: length of litter and residual toxicity of the chemicals, the latter being a variable factor. For pasture establishment a fortnight between spraying and oversowing appears adequate under warm conditions for dalapon and amitrol. Under cool conditions a longer period is required. This is best obtained by applying chemicals in early winter and oversowing in early spring. For arable crops, a complete kill of the existing sward is required, necessitating high spraying rates (10 lb. dalapon and 2 lb. amitrol); at these dosages, particularly for cereals, a month or so should elapse between spraying and oversowing, though for brassicas a fortnight appears adequate as these crops show a fairly high resistance to dalapon.

### Soil Fertility

If low producing species are to be replaced quickly by high producing species, the fertility requirements of the particular soil type must be known and met. It is fairly clear that the fertility requirements of ryegrass, white clover and similar high producing species is not known for the 1,500-odd soil types in New Zealand. Of the low fertility areas, the most successful establishments have occurred on molybdenum-responsive soils. The question also arises whether or not less fertiliser is required where a soil has been cultivated before sowing: initial work suggests that this is not so, and that less fertiliser is required on chemically established areas, where release of nitrogen appears more gradual and complete.

### Time of Oversowing

Locality and aspect are important factors in deciding on when to oversow. In areas of adequate rainfall sowing may be done in spring or autumn but in most areas autumn oversowing is most successful. An annual rainfall of 30 inches and over appears necessary for success. Spring oversowing should normally be carried out earlier than is possible for cultivation. The presence of litter overcomes minor adverse climatic conditions but success depends on selecting the best time for local conditions.

### Seeding Rates

High seeding rates will not overcome deficiencies such as soil fertility, poor kills of sward and incorrect time of oversowing. If all other factors are considered, intermediate seeding rates of 15-20 lb. seed to the acre have proved satisfactory. In pasture renovation a few pounds of seed to the acre has proved satisfactory.

### Management

Apart from the need for adequate top-dressing the area should not be permanently stocked for the first year. Quick on-and-off grazing with a large head of stock is ideal. Many trials have been ruined in New Zealand under set stocking conditions.

## ADVANTAGES OF CHEMICAL PLOUGHING

### Pasture Renovation

By using chemicals to destroy vegetation, pastures may be renovated without cultivation. Most inferior species—

*Close-up of a sward produced by the chemical method (see text), taken about one year after seeding. Note that odd surface-germinating weeds are still present; they will disappear with increasing productivity of the sward.*

Yorkshire fog, *Holcus lanatus*, browntop, *Poa trivialis*, ratstail, *Sporobolus pectinatus*, and the annual species, *Poa annua*, barley grass, goose grass, *Bromus mollis*, all show greater susceptibility to dalapon than the ryegrasses and cocksfoot. These inferior species are normally killed at rates of 2-3 lb. dalapon per acre; this rate checks clover and high producing species, thus reducing inter plant competition long enough to allow the overdrilled species to establish. Where the manurial requirements are met and the area is managed accordingly, large increases in pasture production have been recorded within several months of applying the dalapon.

**Pasture Renewal**

The chemical method allows the direct introduction of grasses and clovers without cultivation. The whole programme may be carried out aerially, thus breaking the barrier between land that can be cultivated and land that cannot. Problems that arise with cultivation, such as consolidation, erosion, the difficulty of cultivating in high rainfall and rock-infested areas, and the destruction of border dykes under irrigation are overcome. Costs are favourable and expensive equipment is not necessary.

**Arable Crops**

To date successful crop establishment has been limited, in trials, to high fertility areas; brassicas and cereals have been grown successfully, and also a few horticultural crops. Elsewhere, the problem is one of fertility: applied nutrients do not reach the rooting zone of the crop and yields are poor. In high fertility areas the crops establish free of weeds; normal cropping weeds such as fat hen, *Chenopodium album*, *Amaranthus* spp., *Polygonum* spp., and spurrey, *Spergula arvensis*, do not establish. Surface-establishing weeds such as thistles have proved troublesome where the crop has failed. The results obtained have been equal to those from cultivation.

With the chemical method, costs are higher than with cultivation because sufficient chemical needs to be applied to kill all species present except the clover, which requires only a severe check. In a trial, the low rate of chemical application used failed to give a complete kill and resulted in poorer yields. However, following cultivation it is usually essential to control weeds with weed killers; if this cost is added to that of cultivation, little or no difference exists in costs between the two methods, and in favour of the chemical method are the facts that the bulbs of swedes and turnips sit on top of the ground, allowing greater utilisation; consolidation is no problem; and the crop may be fed off under wetter conditions.

**Crop and Pasture Rotation**

In areas of high fertility cultivation has the effect of releasing nitrogen quickly and experiments have shown that even where a crop is fed off *in situ* there is a loss of nitrogen. Pastures following such crops are usually grass dominant for up to two years; after this period the proportion of grass is steadily reduced owing to lack of nitrogen, with the eventual result that the area becomes clover dominant. This inbalance of grass and clover usually lasts for a period of four to five years.

Is it possible to reduce the nitrogen loss by growing crops via the chemical method? Early evidence suggests that it is possible to grow crops, particularly swedes and turnips, with a clover bottom. Further evidence shows that it is possible to change from one crop to another by using a chemical desiccant to check the weeds present after the crop is fed off or harvested. It has also been shown that yields are poorer if the surface fertility is ploughed under following a crop. Thus it would appear that by keeping the

*Contrast between sprayed (dalapon) and unsprayed pasture. The only difference in treatments was that the sward in the top half of the photograph was sprayed to reduce inter plant competition.*

fertility on the surface and establishing crops without cultivation, the nitrogen inbalance is not so acute as it is after cultivation.

Further preliminary data indicates that the phosphate requirements are also lower if crops and pastures are established without cultivation. Less response to applied phosphate has been recorded in trials on chemically established swards than with swards established by ploughing. It has also been shown that the composition of the sward is not a reliable indication of its fertility, particularly in the case of swards that have had previous top-dressing. Low producing swards have supported high producing species without the addition of fertiliser, but here inter plant competition was a limiting factor to grass establishment. If surface soil fertility is so important poorer yields may be acceptable in the initial crop provided subsequent crops and pastures do not show a nitrogen inbalance, as is the case following most cultivations.

## DISADVANTAGES OF CHEMICAL PLOUGHING

The chemical method has a number of disadvantages. First, both crops and pastures are slower to establish than after cultivation on both low and high fertility areas. This is probably due to the slower organic turnover than that associated with cultivation; on areas of poor fertility this is particularly emphasised. It is thought that while the organic turnover resulting from chemical ploughing is slower, it is more complete than that resulting from cultivation. The slow establishment of pastures does not lead to a grass/clover inbalance.

Secondly, surface-sown seed is undoubtedly more susceptible to fluctuations in climatic conditions than seed that is drilled into the soil.

Thirdly, the presence of resistant species precludes the use of the chemical method; for example, *Paspalum* species are difficult to kill. Other points are that damage by birds and insects is probably more acute than with cultivation, and the chemical method is probably not applicable to all soil types. Furthermore, where seed requires to be inoculated, poor results have been obtained, except where the seed has been drilled.

## CONCLUSIONS

The various facets of chemical ploughing could make it one of the biggest agricultural advances in New Zealand today, and it has opened up many new approaches to the study of agricultural problems. Is surface fertility important? What are the long-term results of keeping the fertility on the surface? Can nitrogen inbalance following cultivation be avoided, and the amount of phosphate required be reduced? Are the fertility requirements to record a response to annual and poorer strains of white clover those of a ryegrass/white clover sward? In the past fertiliser trials were limited to the existing sward, now a chemically established replicate can also be included.

These are but a few of the problems associated with chemical ploughing. Possibly the biggest limiting factor is the need for a chemical (or chemicals) that has no residual effect in the soil and would not be affected by adverse climatic conditions. Seeding could then be done on the same day as spraying and in the one operation. There is also the question of educating farmers in chemical ploughing: many factors need to be considered if pastures and crops are to be established successfully by the chemical method, and this may call for a better knowledge than is required for cultivation. For this reason alone, until the difficulties are overcome chemical ploughing cannot be recommended for use on a country-wide scale in New Zealand, but the future certainly holds fascinating possibilities.

# Malaria Eradication in India

*Before the Second World War control of the anopheles mosquito, the vector of malaria, was largely confined to the use of larvicides applied to breeding grounds in urban areas. In rural areas little or no control was carried out because the regions to be covered were very wide and the breeding sites numerous.*

*With the development of the chlorinated hydrocarbon insecticides, control in rural as well as urban areas became a practical and economic proposition. These insecticides are not only rapidly toxic to mosquitoes but when applied to a surface they remain effective for some time (up to a year), killing insects alighting on or walking over that surface.*

*Governments of malarious countries throughout the world quickly saw the possibility of raising their economic standards not only by improving the health of their people but by being able to increase agricultural production through bringing into cultivation areas previously made inaccessible by the presence of the mosquito and the disease.*

*National anti-malaria measures with the residual contact insecticides are substantially aided both technically and financially by international organisations—notably the World Health Organisation and the United Nations Children's Fund (UNICEF)—as well as by direct US aid from the International Cooperation Administration.*

*Taking an increasing interest in malaria control, WHO in 1955 introduced a policy of malaria eradication by intensifying anti-malaria measures during a limited period, the object being to eliminate the parasite altogether. A 'survey' phase is followed by an 'attack', when intensive spraying with a residual insecticide is carried out. This phase lasts approximately five years, after which time insecticides are withdrawn from use and a surveillance organisation operates to identify any foci of reinfestation.*

*One of the largest of these eradication campaigns is being undertaken in India and is the subject of the following article.*

*As a footnote, it is of interest that in the last seven years the annual total of malaria cases throughout the world has fallen from some 250 million to 150 million. In the same period deaths from the disease have fallen from an estimated two and a half million to one million a year [Ed.].*

*by* **Dr. Rajindar Pal,** *Deputy Director Malaria Institute of India (NMEP*[1]*)*

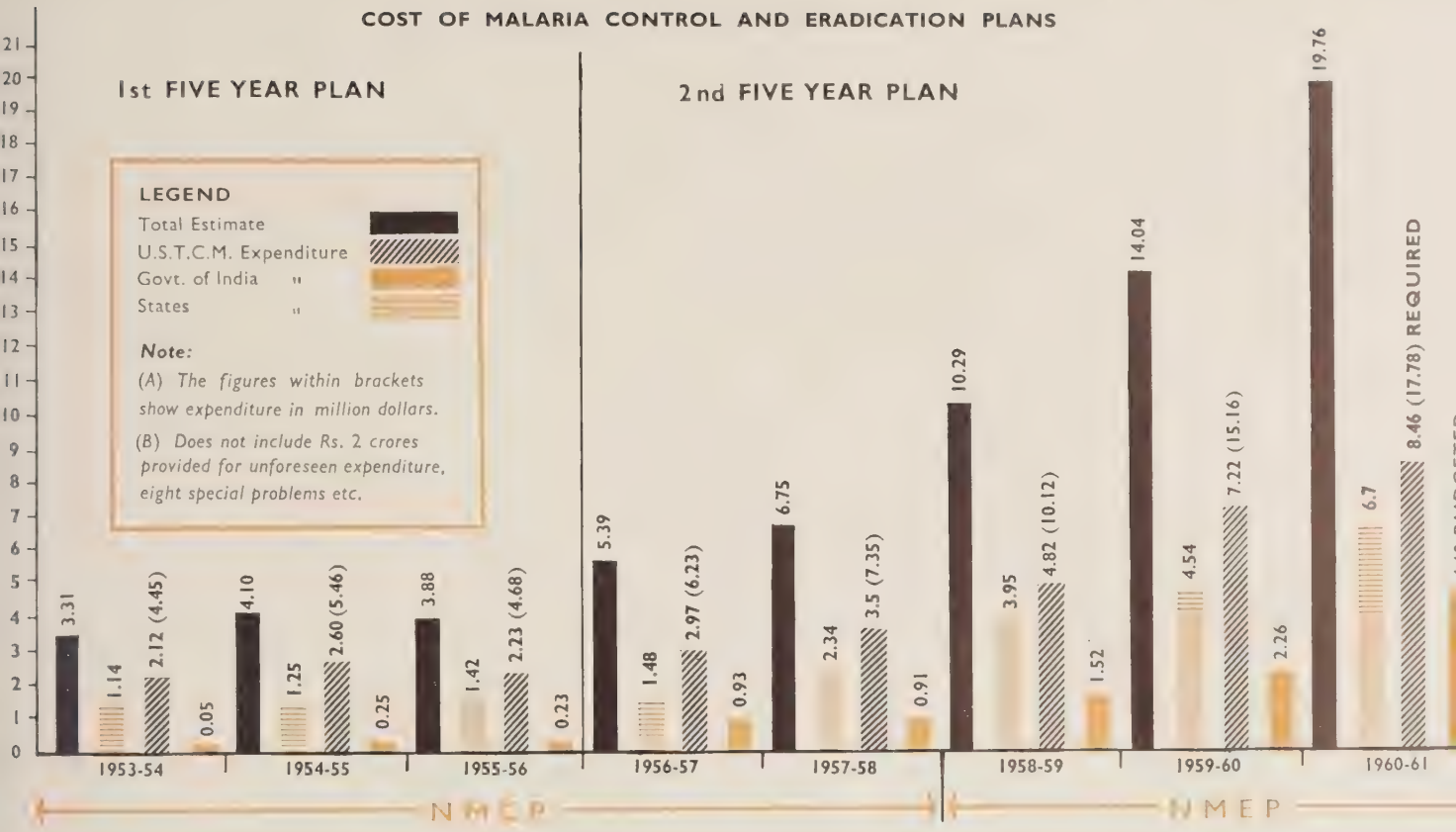
1st April, 1958, will be remembered as a landmark in the history of India, for it was on this date that the National Malaria Eradication Programme was launched to liberate the entire sub-continent from the scourge of this disease. Because of the complexity of the epidemiological factors, the variety of technical problems encountered, the administrative difficulties in a country shaping its new social and economic structures and, last but not least, its sheer size (population 390 million; area 1,269,640sq. miles) the eradication programme in India is certainly a most imaginative venture in the domain of public health.

During the first 45 years of this century while a comprehensive study covering the mode of spread of malaria and measures for its prevention was being made, only an infinitesimal fraction of the enormous problem was being actually tackled—particularly in rural areas—for want of an efficient and economical method of malaria control.

Antilarval measures by chemicals or by water sanitation hitherto practised were inadequate. Remarkable results, were, however, reported from the spraying of pyrethrum solution in houses. Owing to the acute shortage of pyrethrum insecticide during the last war the search for alternative efficient insecticides was intensified, which resulted in the discovery of DDT, BHC and later dieldrin and a variety of other residual insecticides.

Malaria control by spraying these residual insecticides on the inside walls of the houses was made possible because of the fact that after a blood meal a mosquito usually rests on some interior surface before flying out of the house. In addition, the mosquito must survive at least 10-12 days before it can transmit the disease to other persons. As the mosquitoes must frequent the houses regularly to obtain blood, they come into contact with the insecticide deposit

[1]National Malaria Eradication Programme.




on the walls, which are effective for several months, and are killed. As mosquitoes must obtain a blood meal on an average of at least once in two days, their likelihood of surviving beyond 10-12 days and transmitting malaria becomes remote.

### Post-War Control Measures

After the war when DDT was made available for civilian use in India about 30 million people were given protection. But soon a comprehensive programme for the control of malaria was prepared in consultation with USTCM[2], WHO, and UNICEF, as a part of the first Five-Year Plan for the reconstruction of the country. The Government agreed to carry out a National Malaria Control Programme (NMCP) which would receive Point Four American Aid.

The programme which was launched on 1st April, 1953 was designed to give protection to 200 million people considered to be living in malarious tracts of the country. The programme envisaged an operational phase of five years (intensive spraying of the houses) to be followed by a maintenance phase (spraying of insecticides on a reduced scale, if necessary).

The object of the control programme was to bring down malaria transmission in the country to such a low level that the disease would cease to be a major public health problem, thus saving from this disease 75 million sufferers and a million casualties annually. Within the first five years of operation 194 units began functioning, each protecting about one million people.

[2]United States Technical Cooporation Mission.

The later developments in malaria control and research in various parts of the world, however, brought out the following facts:

(a) If malaria transmission were interrupted in an area for a period of about three to four years, the residual malaria would die out and there would be no parasites to be transmitted. Once this stage had been reached the spraying of insecticides could be discontinued. This factor opened the channels for the eradication of the disease.

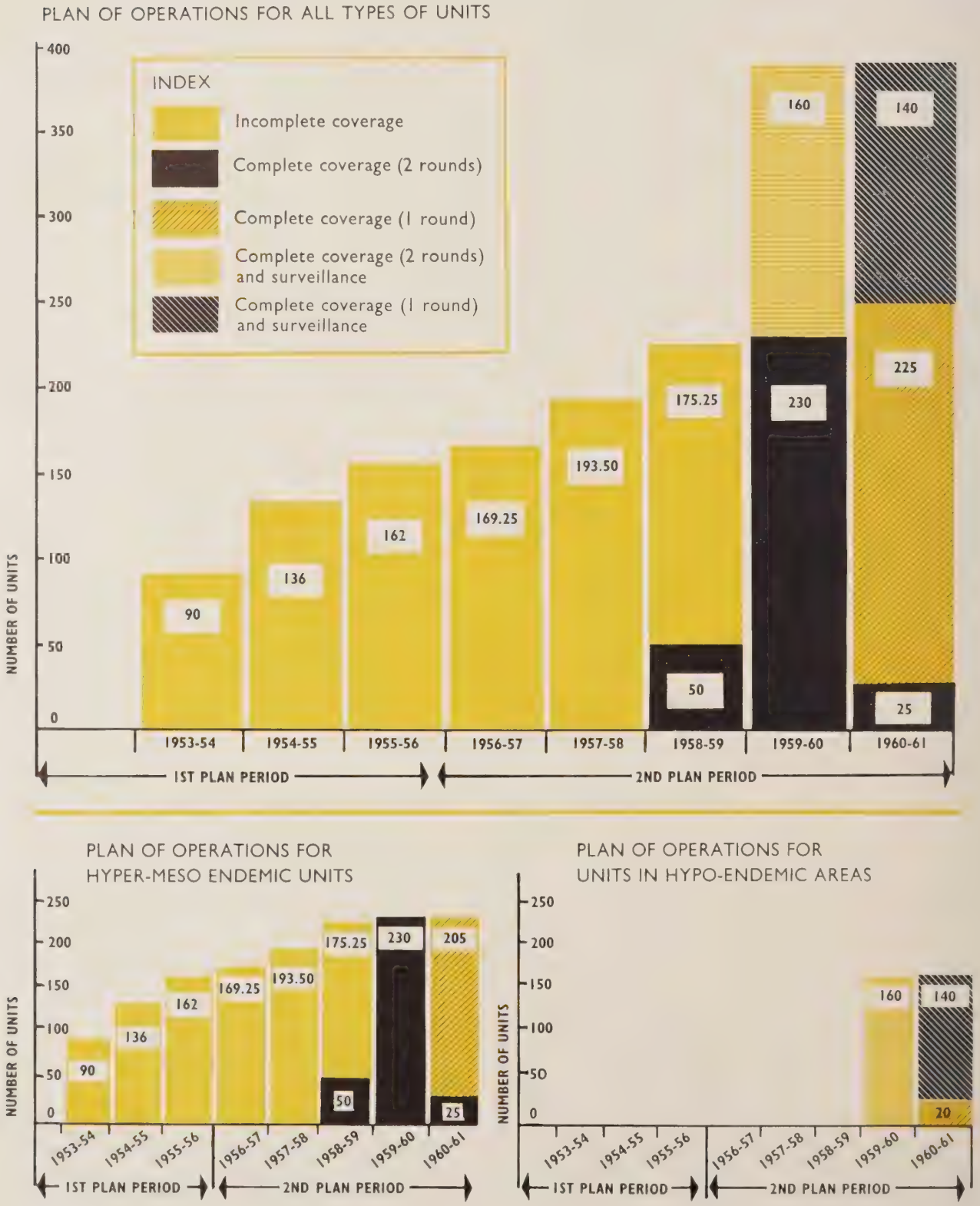
(b) As a result of the continued use of residual insecticides over a long period of time, certain mosquitoes developed resistant strains. This was a warning signal that the job must be accomplished quickly or the opportunity would be lost. This factor generated a sense of urgency.

(c) Spraying of insecticides indefinitely in a control programme meant recurring expenditure indefinitely, whereas in an eradication programme, although the initial expenditure was high, there would be no recurring expenditure and hence it would be more economical.

### Eradication

These observations led to the revision of the original strategy throughout the world, and eradication rather than control became the object of anti-malaria measures. In India the control programme was converted to the National Malaria Eradication Programme in 1958. For obvious reasons an eradication programme must include the less malarious regions as well as the highly malarious

# National Malaria Eradication Programme, India
## Operation Plans



areas. This approach in India meant that practically everybody in the country would need protection.

In order to achieve the goal of eradication, the plan consists of three phases: attack, consolidation and maintenance. The attack phase is aimed at total interruption of transmission by spraying with residual insecticides all roofed structures throughout the country. In some areas this entails one spray round a year, while in other areas two rounds are necessary. Treatment will continue for three to four years, depending on the results obtained.

In the consolidation or surveillance phase which follows, house to house visits will be made in an attempt to detect and treat all remaining malaria cases. However, before spraying is withdrawn from any unit area it must be demonstrated that: (a) the child spleen rate is below five per cent.; (b) the child parasite rate is below one per cent.; (c) the infant parasite rate is 0 per cent. for two consecutive years; and (d) there is no evidence of indigenous transmission by surveillance procedures during the year before the contemplated withdrawal of spraying. This phase, which must be initiated before the end of the attack phase, will last at least three years.

The maintenance phase is in reality a partial continuation of the consolidation phase. It is in fact a continued vigilance by the normal public health staff, to discover the development of any malaria cases and to take such measures as may be indicated to cure those cases and prevent further transmission.

Unlike some other countries, the actual operation of the programme rests with various States in India but the direction and coordination is by the Central Government. The Central Government also makes available supplies for the programme and gives a subsidy for the staff. A number of units for both endemic and hypo-endemic areas have been allotted to each State, depending upon the size of the population in the area of each type.

### Current Results

During 1959-60 practically all the 390 units (230 in endemic regions and 156.75 in hypo-endemic regions) have been functioning. The child spleen rate has dropped from 20.3 to 0.2, the child parasite rate from 3.8 to 0.04 and the infant parasite rate from 12.9 to 0.02 over the country as a whole during the past five years. Estimates of actual morbidity and mortality are difficult to make. However, it would appear from the available data that malaria in the country has been reduced from 75 million cases to less than five million. This latter figure is probably much lower because most of these cases are clinically diagnosed as malaria cases and only a small percentage has been microscopically verified.

It is hoped that during the third Five-Year Plan (1961/2 to 1965/6) there will be gradual withdrawal of spraying throughout the country. There may remain a few pockets of persistant malaria in problem areas which will have to be dealt with by special measures. However, if everything goes according to plan, malaria will cease to exist in India by 1965-6, and large numbers of trained public health workers will be available to tackle other communicable diseases.

**FACTS AND FIGURES—INDIA'S MALARIA ERADICATION CAMPAIGN**

| | | | |
|---|---|---|---|
| **1.** | **Finance required** | Approximately 1,300 million rupees, much less than half the amount of the present yearly losses. | |
| **2.** | **Manpower required** | 150,000 personnel of all categories (medical officers, inspectors, technicians, spray workers, etc.). | |
| **3.** | **Supplies*: (1953-1959)** | *IMPORTED* | |
| | *Insecticides* | DDT 75% | 146,593,270lb. |
| | | Dieldrin 75% | 20,000lb. |
| | | Dieldrin 50% | 1,145,512lb. |
| | | *INDIGENOUS* | |
| | | DDT 75% | 97,180lb. |
| | | DDT 50% | 16,721,936lb. |
| | | DDT Technical | 2,570,400lb. |
| | | BHC 50% | 5,510,400lb. |
| | *Transports* | 2,255 | |
| | *Sprayers* | 64,707 | |
| | *Microscopes* | 1,025 | |
| | *Anti-malarial drugs required during the next four years* | 950 million tablets. | |
| | *Microscope slides required during the next four years* | 112 million. | |

*Most of the insecticides, transport and microscopes were supplied by the USTCM. UNICEF/WHO also supplied some insecticide and assisted in setting up a DDT factory in Delhi.

# TRANSPORT AND HANDLING

*by* **J. A. C. Gibb,** *University of Reading.*

On every farm, the production of crops and of animal produce depends to a great extent on transport. In growing a crop, seeds, fertilisers and manures must be taken to the field from storage points, and the harvested crop has to be carried back to a storage or dispatch point. In many cases transport equipment is also required to bring materials such as seeds and fertilisers on to the farm, and to carry away the final products.

Transport is thus basic to agricultural production, and in many instances may be responsible for an appreciable fraction of the costs of production. While mechanisation of field work and, to a lesser extent, of work concerned with animals, has been proceeding rapidly for many years, farm transport comprises such a wide range of activities, and is hedged around with so many difficulties, that in the past comparatively little progress has been made in improving its efficiency and reducing its cost.

**The General Problem**

The difficulties can be summarised by saying that very often relatively small quantities of widely differing types of material, usually in forms which are not particularly easy to handle, have to be moved over surfaces which are frequently rough, soft or slippery. The types of storage buildings or facilities, and of those in which food materials are actually used, often impose limitations which, combined with these other factors, delay the introduction of efficient transport methods.

During the past 30 years two major contributions towards improving farm transport vehicles have been made—the agricultural pneumatic tyre and the tractor hydraulic lift system, which permits the use of hydraulically tipping trailers. In the most advanced countries other facilities, usually of a comparatively costly nature, have also been introduced fairly recently. These include such items as self-unloading trailers, many types of conveyors, and pallet or stillage handling equipment[1]. Even so, much laborious manual work still remains.

One attempt to study the problem has been made by the United Nations Economic Commission for Europe. Their report[2] summarises the basic problems and refers to methods of transport in use in European countries and the USSR. It draws attention in particular to the importance of labour-saving loading methods as essential ancillaries to the actual movement of materials, and also to the necessity of adequate public and farm roads if transport equipment is to be used efficiently.

A section of particular interest deals with the costs and 'productivity' of different methods of transport. Since a

[1]Pallets and stillages are platforms and/or containers used for material handling and transport by fork-lift truck and similar equipment.

[2]*The General Problem of Transport on the Farm*, AGRI/MECH/14, United Nations, Geneva, Sales No. 59.II E/Min. 19.

*The modified front loader is one type of relatively inexpensive substitute for a fork-lift truck. In this model, pull-rams in the parallel linkage members provide a means of tilting the fork slightly backwards or forwards.*

# ON THE FARM

*The rear-mounted fork-lift attachment provides the farmer with most of the advantages of an industrial fork-lift truck for pallet handling and stacking purposes. Light trailers can be hitched automatically, without removing the attachment.*

wide range of types of agriculture and degrees of mechanisation is included in the survey data, the results are clearly not of general application to the more highly-mechanised countries. The basis for comparisons of productivity, for example, in most cases is taken to be a horse-drawn, steel-wheeled cart—a form of transport which is now of very limited application in Great Britain at least. Reference is also made, at the other extreme, to specialised loading machines of Russian design for hay, manure and sugar beet.

**Farm Transport in Great Britain**

In Britain there are more farm tractors per 100 acres than anywhere else in the world, and these tractors are used, on average, for about one-third of their time on transport work. On some farms one-half or even more of tractor time is spent in this way. Pneumatic tyres on tractors and trailers are invariably to be found, and many of the trailers are of the hydraulically-tipping type. The equipment for transporting materials is thus widely available, in an efficient and economical form. In most areas the public road system is fully adequate, serving with metalled roads even the smallest farms.

What prevents the most efficient use of this equipment is, therefore, the lack of adequate loading (and sometimes unloading) facilities, together with the fact that many materials are not in the most suitable condition or containers for easy handling. As a result, in the majority of cases manual work is involved at almost every stage of handling.

From the handling point of view, materials can be classed either as free-flowing or as non-free-flowing. If the former, they may be moved in a continuous stream or, alternatively, they may be loaded into bulk containers which are then treated as unit loads. Non-free-flowing materials may either be large enough (e.g., bales or sacks) to be handled as individual loads, or may be assembled in groups in such a way as to permit handling them as unit loads. The choice of the most suitable handling method is therefore by no means fixed.

**Free-flowing Materials**

Generally speaking, free-flowing materials are easier to handle mechanically than the others. But in certain cases, materials which are intrinsically free-flowing—such as seeds, animal foods and some kinds of fertiliser—are often more conveniently managed by the farmer as small unit loads, perhaps in 1cwt. sacks. The advantage here is that the weighed unit quantities make it possible to keep a check on sowing, rationing or application rates.

It should be noted, however, that the handling of free-flowing materials usually involves the use of conveyors, which normally will be more efficient in saving labour and fatigue if they are fixed in position in or between buildings. They then become special-purpose machines, the installation and operating costs of which can be spread over enterprises of only limited size. If such special-purpose equipment is to be an economic proposition, it may be essential to increase the size of the enterprise in question. There are, of course, conveyors of general application, which are most useful machines. Their ability to save labour and capital expense by dealing with a wide range of tasks is nevertheless diminished because it is necessary to spend a certain amount of unproductive time in moving them from place to place and in adapting them from one job to another.

Continuous-flow methods of bulk-handling grains of various kinds are an inevitable consequence of the introduction of the combine-harvester, and there seems little point in reconsidering them. Under the *technically* best systems of handling grain[1], there should be no need for it to be touched by hand at any stage. The main principle to adopt is to load it at the first stage, and at subsequent key stages, high enough to make use of gravity for intermediate movement. The whole pattern of movement must be conceived as an integrated system. Certain other materials, such as short-chopped grass for silage or green-feeding (and—looking to the future—pelleted hay) can be handled in similar ways.

**Unit Loads**

It is with non-free-flowing materials that the problems and the need to rationalise choice of equipment are greater. Probably a system of unit loads of 5cwt. to 10cwt. is likely to offer the greatest advantages of both labour-saving and versatility of application. In the first place, however, one requires a method of handling unit loads of such a weight. Bearing in mind that the tractor is the most widely available item of equipment on British farms, it would seem commonsense to look for methods of adapting it for handling purposes. Possible adaptations include the use of cheap rear-mounted carrying forks, or, at greater expense, the use of modified front- or rear-mounted hydraulic loaders, or fork-lift attachments. The two last-mentioned devices offer the possibility of stacking unit loads in tiers in order to make maximum use of the so-called 'air rights' (i.e., the internal height to its maximum) in a storage building. All three devices offer means of loading and transporting (over short distances at least) practically all types of farm materials.

It is true that the unit loads have to be formed in the first place, before they can be handled by the tractor attachment. This may have to be done manually in some cases, for example by arranging perhaps eight or 10 paper or jute sacks on a pallet, or by filling a container with potatoes—either by hand or from the delivery conveyor of a harvester.

As has already been mentioned, for certain purposes of easy measurement, packaging of some materials in sacks is very convenient. In other circumstances, further economies in labour may result from dispensing with the sacks, and handling in 5cwt. to 10cwt. bulk loads in suitable containers. These containers can be discharged—into animal feeders, seed drill or fertiliser distributor hoppers, etc.—by means of a tipping mechanism on the front loader fork or fork-lift attachment.

**Complementary Systems**

It would seem, then, that for some time to come, there will be room on British farms for two different approaches to

[1](As distinct from the *economically* best systems.)

the mechanisation of transport and handling work. On the one hand, free-flowing materials such as grain, milk, and perhaps chopped silage, will be handled in bulk at every stage from production through processing to use, or sale off the farm. Complementary to such bulk-handling methods, there is scope for the handling of practically all kinds of farm materials in small batches or unit loads, by means of pallet or container systems.

However, to be thoroughly effective, both systems must be carried through completely from beginning to end, and this will mean that they cannot start or stop at the farm gate. Bulk selling of grain requires that the buyer has vehicles capable of receiving a bulk load, while the handling of materials such as seeds, foods and fertilisers in lots of eight or 10 bags on pallets can only be most effective if they are delivered to the farm on such pallets. At the other end, it may be possible to send some commodities as far as the retail market in pallets or other containers, and this is now being done to some extent with apples.

The capital investment in handling equipment, whether it be in the form of conveyors, tractor attachments, bulk bins or pallets, is obviously an item to be reckoned with. Labour can only be saved, however, by judicious capital investment in equipment, and it is up to the farmer to ensure that the saving will more than offset the expenditure. In choosing such equipment, he will obviously take into account the possibilities of rationalising production so as to increase the volume over which the capital investment will be spread. He should also use work study methods to guide him as to the best methods of using the equipment. Reappraisal of the handling of the materials he is concerned with is incomplete without taking into consideration storage and feeding buildings, and indeed probably the most vital factor in considering the design of new farm buildings is the extent to which they facilitate the use of the handling methods discussed above.

*An auger for conveying silage or green feed to yarded cattle. Chopping is a prerequisite if grass or other green material is to be handled in this way.*

*Gutter cleaners are normally used to remove manure from buildings. Here a continuous-chain machine is situated at the corner of a cattle yard, and is used to elevate into a manure spreader dung scraped to it by a tractor-mounted scraper blade.*

**Labour Productivity**

So far, little mention of the 'productivity' of labour employed on transport work has been made. It is difficult to measure productivity in this sense unless comparisons between alternative methods can be made over reasonably long periods of work, such as days on end. Much farm transport work cannot be isolated as an operation on its own, since it forms part of an integrated sequence of operations. In trying to assess the efficiency of the use of labour on transport tasks, one must therefore take into account the relationships with the other operations that the transport task is associated with. Even so, there is a serious lack of information on the efficiency of labour use in transport and handling work.

An assessment of the contribution which can be made by pallet and other handling systems to the farm economy would be of considerable value to farmers, who are now perturbed by the large proportion of man and tractor working hours accounted for by transport and handling operations—remembering that these add nothing to product values, but only to the cost of production.

# Farm Management and Work Study in Britain

*by* **G. W. Lugg**

The best of British farming is probably as efficient as any in the world to-day. Efficiency, measured in output per acre, per £100 capital, £100 labour or any other yardstick is high. On these really efficient farms certain trends are clearly visible: whatever enterprises are in operation they are each run as highly specialised units, being large enough to occupy at least one man whole time; and good stock, new high yielding crop varieties, modern fertiliser practice, better use of grassland are all required. In addition, skilled labour use well designed machinery and work in well laid out buildings. All these factors, together with a modern business approach, contribute to highly efficient farming units to-day.

Recently a series of techniques new to farming, known as work study, has been introduced. Work study is aimed at helping the farmer make the best use of his resources—labour, machinery and capital. The reduction of drudgery and the elimination of useless work are important features of a work study exercise, the aim of which is to aid farm management in making work more effective. Startling increases in productivity have been achieved by the proper use of work study techniques.

Just how important it is to use labour and machinery properly is illustrated by the chart below, showing the composition of farmers' expenses.

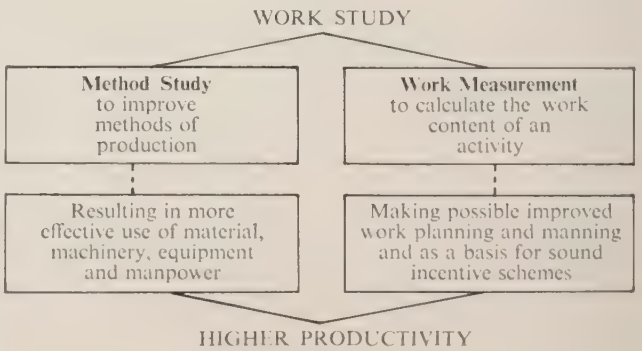
Thus it can be seen that labour costs are over 25 per cent. and machinery costs over 20 per cent. of expenses.

There are many indications that they will rise even more in the future.

Work study techniques were first tried out in farming in Britain in 1926 by Dunlop, but without creating much interest, and it is only within the past five years that any real effort has been made again, although in 1942 a 'farm work simplification' project was started at Purdue University in the USA. Soon after the last world war investigations were also carried out in the Netherlands and other European countries and now much effort is spent on this subject.

### The Techniques of Work Study

The techniques of work study have been applied in manufacturing industry for many years; recent investigations, however, have shown that the techniques are equally applicable to the agricultural industry. Work study is split for convenience into two main sections, as shown below.


WORK STUDY
Method Study
to improve methods of production
Work Measurement
to calculate the work content of an activity
Resulting in more effective use of material, machinery, equipment and manpower
Making possible improved work planning and manning and as a basis for sound incentive schemes
HIGHER PRODUCTIVITY

### Method Study

The function of method study is to record systematically, analyse, and examine critically the methods employed in the performance of existing or proposed ways of working.

The procedure is laid down and it is important to keep to it. None of these stages can be omitted:

**Select** the work to be studied;

**Record** all the relevant facts of the present (or proposed) method;

**Examine** those facts critically and in sequence;

**Develop** the most practical, economic and effective method;

**Install** the method as standard practice;

**Maintain** that standard practice by regular routine checks.

### Select

The selection of the correct job for method study is of the utmost importance. Indications of the need may be given by high bills for overtime, difficulties due to seasonal labour peaks, or excessive physical effort for certain jobs. But by far the best way to select the job is by analysing farm accounts: if output per £100 labour appears low, further study will show the enterprise responsible. Actual performance can be compared with the standards available in *The Farm as a Business*[1] published for the British Ministry of Agriculture, although it should be stressed that these standards are based on average performance and good work studied systems will require much less labour.

### Record

A wide variety of techniques can be used for recording the method in use; those actually applied will depend on the particular investigation and the type of work involved. For example, charts of various types, diagrams, models and photographs may be used. The construction and interpretation of charts is simplified by using the following symbols, covering, between them, all types of farm activity:

| *Symbol* | *Activity* | *Predominant Result* |
|---|---|---|
| ○ | **Operation** | produces, accomplishes, furthers the process. |
| □ | **Inspection** | verifies quantity and/or quality. |
| ⇨ | **Transport** | travels. |
| ▽ | **Storage** | holds, keeps or retains. |
| D | **Delay** | interferes or delays. |

Such symbols enable a large amount of information to be assembled on a single sheet, as the following example shows:

**Bottle Washing**

**Flow Process Chart of Proposed Method**

| | |
|---|---|
| ▽ | Crate waiting in stack. |
| ⇨ | Crate placed on end of washer. |
| D | Crate awaiting levering into washer. |
| ⇨ | Crate levered in. |
| ○ | Crate washed. |
| ⇨ | Crate placed on conveyor. |
| ⇨ | Crate to bottling room. |
| D | Crate waiting. |
| ⇨ | Crate placed on filler. |
| ○ | Crate filled. |
| ○ | Crate capped. |
| ⇨ | Crate placed in stack. |
| D | Crate waiting in stack. |
| ⇨ | Crate moved to cold store. |
| ▽ | Crate waiting in cold store. |

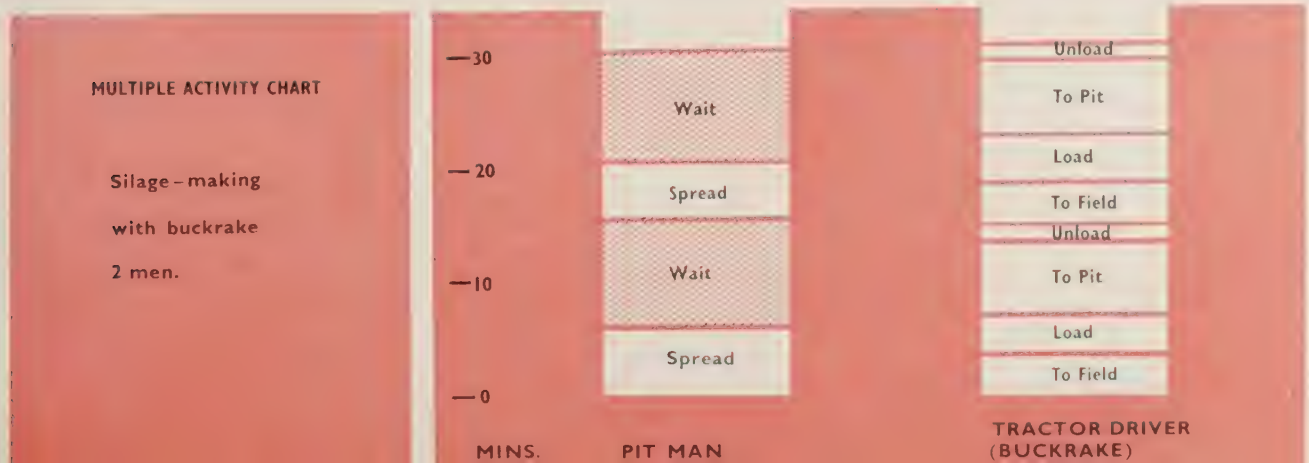
The multiple activity chart (see below) provides another useful type of record. In this the relationship between the work of members of a team or men and machinery is shown on a time scale. Different activities are denoted by various colours or shadings.

Diagrams of different types are also useful, one of the most popular being the string diagram. In this, by means of cotton and pins placed at points of change in direction, the paths of movement of men are plotted on a scale diagram. Such a diagram shows immediately where movement is congested as well as distances travelled.

### Examine

Having ascertained the facts, the important sections of the work are critically examined, and a series of questions about

[1] *The Farm as a Business*, Her Majesty's Stationery Office, London, 9s.



each part of the job is asked. If an answer to one of these is unsatisfactory then attention is focussed on finding ways and means of eliminating, modifying or superseding that particular operation. The questions may be summarised as follows:

**Purpose** *What* is achieved?
Is it necessary? *Why*?
What *else* could be done?
What *should* be done?

**Place** *Where* is it done?
*Why* is it done *there*?
Where *else* could it be done?
Where *should* it be done?

**Sequence** *When* is it done?
*Why* is it done *then*?
When *else* could it be done?
When *should* it be done?

**Person** *Who* does it?
*Why* does *that person* do it?
Who *else* could do it?
Who *should* do it?

**Means** *How* is it done?
*Why* is it done *that way*?
How *else* could it be done?
How *should* it be done?

### Develop

Careful consideration of the answers to the above questions will lead to the development of the new method. Very often specialist technical information will be required at this stage. The new method is then charted and subjected to the same process of examination as the existing method.

### Install and Maintain

This part of the procedure is mainly the responsibility of the farmer. It is often necessary for slight adjustments to be made to allow for local conditions, stock types, weather, etc. However, once the new method is installed it is important to maintain it by periodic checks.

### Work Measurement

This aspect of work study is becoming increasingly important in agriculture. Work measurement is used to discover how long a job *should* take. The work is timed in elements, these being only of a few seconds' duration. An allowance is then made for the speed and effectiveness with which the operator is working and a further allowance made for rest. Thus a *standard time* is calculated for each work element of the task. These standard times or reference data are of considerable use in comparing methods of work for incentive schemes, and in such jobs as milking routines for instruction purposes.

### Work Study Examples

During the past four years a wide variety of investigations has been carried out; such tasks as machine milking, crop spraying, mixing and milling, pea vining, hop picking, pig feeding, and silage making have all shown really worthwhile results. In most cases the studies have related to the overall farm management, and policy changes leading to increased profit have occurred.

It is important to appreciate that modern farm management techniques will decide *which* enterprises a farm should run. Work study will then indicate the detailed method of working them. Two of these investigations are described in more detail below:

*Pig Feeding and Watering.* On a 400-acre beef and arable farm a pig unit of approximately 30 sows was kept. All progeny were sold either at bacon weight or as fat hogs. The sows and litters from about three weeks to weaning at eight weeks, and also the dry sows, were kept outside on grass in paddocks made by using an electric fence.

The original layout is shown as Diagram 1. Food and water were brought round daily by the pigman, using a horse and dray, the sows feeding inside their paddock and the small pigs creep feeding in the passages between the paddocks. Apart from this daily routine other work consisted of moving sows and litters from the farrowing house to the field, moving weaners from the field to the fattening house, and moving sows to the boar. Also, the electric fence had to be moved two or three times a year, together with the arks and troughs.

A method study was carried out and a new layout has been evolved. This is circular in pattern with a central work area holding watertight feed bins, filled weekly, and creep feed troughs for the small pigs. In addition, water is laid to this central area by polythene pipe. This is shown in

Diagram 2. The work involved can be summarised as:

| | *Original Method* | *Improved Method* | *% Saving* |
|---|---|---|---|
| Approximate distance walked by pigman inside the field | 7,800 yards per week | 2,000 yards per week | 74.4 |
| Time taken feeding and watering | 6 hrs. 18 mins. per week | 1 hr. 37 mins. per week | 74.3 |

Other advantages of the improved method are a saving in food by reducing wastage involved in the original *ad lib.* feeding, and the provision of more time for vital stock husbandry.

This study was part of a longer one covering all aspects of a 30-sow pig unit looked after by one man. After all parts of the enterprise had been investigated—fattening, farrowing, mixing and milling food—it was possible to increase numbers to over 60 sows, still looked after by one man, but with much easier work and more time for stockmanship.

*Poultry Processing*. Interesting work has been carried out in industries ancillary to farming, such as agricultural merchanting, poultry hatching and poultry processing.

A full work study was carried out in a poultry processing station producing about 4,000 uneviscerated birds weekly. As a result of the investigation the plant layout was redesigned, various pieces of new equipment were recommended and new methods installed. The effect of all the recommendations was as follows:—

| | *Original* | *Proposed* | *% Saving* |
|---|---|---|---|
| Numbers employed | 15 | 9 | 40 |
| Man-hours per day | 122 | 72 | 41 |
| Processing time | 17.9 mins. | 6.6 mins. | 63 |
| Space required | 3,510 sq. ft. | 2,460 sq. ft. | 30 |
| Output, birds per hour | 103 | 179 | 74% increase |
| Birds per man-hour | 7 | 20 | 285% increase |

One very important aspect was the space saved, which was valuable for other purposes. Less labour was required but there was no question of redundancy as staff were urgently needed in another part of the company's business.

**Building Plans**

Work study can be very usefully employed when designing new farm buildings, or making alterations to old ones. Many millions of pounds are spent annually on farm buildings and there is no doubt at all that much is spent unwisely.

The routine for work study in design is much the same as for existing work methods: the proposed method is recorded, critically examined and a new method developed. Certain standard information is now available and so studies can be carried out more quickly than hitherto. Reference data obtained by accurate work measurement can be used to synthesise the proposed method of working in a building and, of course, to synthesise methods in alternative layouts. Strict comparisons can then be obtained to assist in the choice of design.

**The Future**

Work is now being carried out on the collection of standard information. Thus, to some extent, expensive time-consuming investigations will not always be necessary.

Often farmers ask: 'If I save time what can I do with it?'. Obviously, there are many ways of utilising time saved as a result of work study investigation. A farm management analysis often shows that production is low, although the farmer is working 12 hours a day; good work studied routines will cut his daily chores and so allow time to keep more stock or start a new enterprise in order to increase the farm production. Time saved may be used for management functions, keeping records, etc., and, of course for all-important leisure.

In certain cases a study may have as its main aim the reduction of drudgery. This is a very valuable aspect of work study and should help to raise the status of the farm worker. There seems no doubt that farm wages will rise in the future and become comparable with wages in industry generally, so these is great justification for eliminating needless, frustrating and back-breaking work on British farms. There is no question of farm workers becoming redundant as a result of work study, for only five per cent. of British farms employ four or more men: rather will work study help to increase their productivity.

It must be appreciated that work study is no panacea: it is an aid to management and not a substitute for it. It is one more tool available to the farmer and his advisers, a tool that, used wisely, can help considerably in the times of keen competition which are certainly ahead of British agriculture.

# Weight or Volume?

*by* **R. E. Gill,** B.Sc., Ph.D., *Shell International Chemical Company.*

It is not uncommon to find references in technical literature to products, such as agricultural formulations, containing 'X per cent.' of some particular ingredient. The ambiguity of this type of expression indicates confusion of thought and gives rise to misunderstandings which may well have serious practical consequences.

If it is said that a solid formulation, such as a dieldrin wettable powder, contains, say, '50 per cent.' of the insecticide, it may be assumed—in all probability quite correctly—that 100 parts by weight of the wettable powder contains 50 parts by weight of the insecticide. Nevertheless, it would seem desirable, in order to dispel any possible doubts, to express the concentration of insecticide in the product as a percentage *by weight.*

If one is concerned with the concentration of some dissolved substance in a liquid formulation, such as a solution or an emulsifiable concentrate, the expression 'X per cent.' is virtually meaningless. It is important for practical purposes to express the concentration in terms which leave no room for doubt. In what terms, then, should the concentration of the dissolved substance preferably be expressed?

The substance which is dissolved (i.e., the solute) may be a solid or a liquid, and this makes it possible to express its concentration in various ways, thus:

100 litres of the solution may contain X litres of the (liquid) solute. The concentration is then X% v/v.

100lb. of the solution may contain Xlb. of the solute (which may be a solid or a liquid). The concentration is then X% w/w.

100 litres of the solution may contain XKg. of the solute (which may be a solid or a liquid). Such a concentration is conventionally referred to as 'X% w/v'.

It has long been the practice amongst scientists to express concentrations of solutions in terms of the number of grams of solute contained in 100ml. of the solution and the concentration in g./100ml. is referred to as the 'per cent. w/v'. It will, of course, be realised that a concentration expressed as g./100ml. must be synonymous with the concentration expressed as Kg./100 litres and it can be shown by a simple calculation that this concentration is also synonymous with lb. (of solute) per 10 Imperial gallons (of solution).

The universal adoption of the 'per cent. w/v' method of expressing concentration has many practical advantages. It takes into account the facts that volume changes may take place when two different liquids are mixed together; that a dissolved solid occupies some 'room' in the solution and that the change in volume consequent upon the dissolution of the solid cannot be calculated—it has to be determined by experiment; and also that different solvents will give rise to solutions (containing the same concentration of the same solute) which will have different densities. Irrespective of all such considerations, the concentration, when expressed on the 'per cent. w/v' basis, does not vary.

**Advantages in Agriculture**

The expression of concentration as a percentage 'w/v' also has advantages in agricultural practice generally. When, for example, a new solid insecticide is introduced, trials are first arranged to establish the rate at which the insecticide should be applied to different crops, so as to control particular pests. As a result of such trials, it is commonly recommended that the insecticide should be applied at the rate of Xlb. per acre or Y Kg. per hectare, and these recommendations are made known to the ultimate users. In this way, the farmer learns that he should apply, say, 0.5lb. dieldrin per acre of a particular crop.

Meanwhile, the insecticide has to be formulated. If it is decided that a dust containing 2 per cent. w. of dieldrin is best suited for the purpose in question, the farmer has no problem. As the recommended dosage rate for the insecticide is 0.5lb. per acre, he will have to apply 25lb. of the dust (containing 2 per cent. w. dieldrin) per acre.

If, on the other hand, it is decided that the pest in question could be best controlled by spraying the crop with an aqueous emulsion containing dieldrin, the farmer will then purchase supplies of an emulsifiable concentrate which has to be measured out and diluted with water. It will be most convenient for the farmer to measure out a certain volume of the emulsifiable concentrate. If the formulator provides the farmer with an emulsifiable concentrate containing, say, 20 per cent. w/v of dieldrin (i.e. 20g. of dieldrin/100ml. EC, i.e. 20Kg. of dieldrin/100 litres of EC, i.e. 20lb. dieldrin/10 IG of EC), the farmer is still without a problem. He merely has to measure out one Imperial quart of the EC, which he knows will contain 0.5lb. dieldrin. This quantity of the EC is then diluted with the appropriate quantity of water and the emulsion so obtained is applied to one acre of the crop.

From the formulator's point of view, the 'per cent. w/v' method of expressing concentration is of particular convenience because it renders of no consequence variations in the purity of the technical insecticides he must use, and changes in the specific gravity or the amounts of the solvents or emulsifiers which he employs—notwithstanding the fact that these changes are reflected in variations in the

specific gravity of the final product. Irrespective of such changes or variations, a given *volume* of his product will always contain the same *weight* of the insecticide. (This last statement is theoretically true only if the volume is always measured at the same temperature. In practice, however, variations in 'room temperature' are not large and they do not introduce errors likely to be of practical significance.)

An example may serve to illustrate the points which have been made above. Suppose the formulator sets out to produce an EC containing 20 per cent. w/v of endrin. The ingredients which he will use will be technical endrin (which may contain, say, 95 per cent. w. endrin), the emulsifier or emulsifiers which he has already found to be most suitable, and the solvent which for various reasons is preferred. The composition of his product may then be:

| | |
|---|---|
| Technical endrin | 21g. |
| Emulsifier A | 4g. |
| Emulsifier B | 3g. |
| Solvent | Sufficient to make 100ml. |

The concentration of endrin in this product will be 20 per cent. w/v irrespective of variations in the percentage of emulsifier(s) or in the specific gravity of the solvent.

**Liquid Biocides**

Different considerations apply if a new biocide, which happens to be a liquid, is developed. In the trials which are carried out to determine the quantity of this biocide required to control specific pests, it will usually be convenient (because the biocide is a liquid) to express the required dosage rates in terms of a given volume of the biocide. In consequence, the farmer may, for example, be recommended to use, say, 100 litres of a soil fumigant such as 'Nemagon' to treat a certain area of soil and it may be preferred to apply the fumigant in the form of an emulsifiable concentrate. In such circumstances, it will be most convenient for the farmer to use an EC in which the concentration of 'Nemagon' is expressed as a percentage 'v/v'. If the product supplied to him contains, for example, 75 per cent. v/v of 'Nemagon' he will know that 100 litres of the EC contains 75 litres of 'Nemagon' and it is a simple matter for him to calculate the volume of EC required to treat the area of soil in question, having regard to the recommended dosage rate. As it happens that 'Nemagon' has a high specific gravity (about 2, at 20°C), it follows that an EC containing 75 per cent. v/v of 'Nemagon' will also contain a much greater proportion of 'Nemagon' by weight (the figure may be about 86 per cent. w/w).

**American Gallons**

The arguments set out above may be summarised by saying that the producer and the customer alike have much to gain by adopting the 'per cent. w/v' basis for expressing the concentration of solid biocides in liquid formulations. This convention is appropriate particularly in those countries where the commonly used units of weight and volume are kilograms or pounds, and litres or Imperial gallons. It is, nevertheless, important to bear in mind that these units are not commonly used by the agricultural community in the USA and in certain countries where the American terminology has been adopted. The American gallon represents a substantially smaller volume than the Imperial gallon and gross errors would therefore arise if the two units were to be used interchangeably.

Whereas a solution containing Xg. of insecticide in 100ml. (i.e. Xlb./10IG) can also be said to contain X per cent. w/v of that insecticide, the adoption of the American gallon as a unit of volume makes it impracticable or misleading to speak of a percentage. For example, a solution containing 20lb. of endrin per 10AG can certainly not be described as '20 per cent. w/v'. In fact, as 10IG represent the same volume as 12AG, the solution in question would contain 24 per cent. w/v of endrin (i.e. $20 \times \frac{12}{10}$ lb. of endrin per 10IG).

The common practice in the USA is to refer to the number of pounds of solute which are contained in one (American) gallon of the solution. For example, emulsifiable concentrates containing '1.6lb. of endrin per gallon' are often offered by American formulators. Such products contain 19.2lb. of endrin per 10 *Imperial* gallons (i.e. 19.2 per cent. w/v) and the percentage of endrin by *weight* will vary according to the specific gravity of the ingredients and, hence, of the final solution.

It is surprising that the facts discussed above are so often misunderstood by those who have much to gain by understanding the simple issues which are involved. The aim of this article has been to show how errors of real practical significance must arise if purchasers or suppliers of liquid formulations refer loosely to 'the percentage' (e.g. of an insecticide in a solution) or to the amount of the insecticide in 'a gallon'. It is obviously in the interests of any purchasing authority to specify the concentration (e.g. of an insecticide) that he requires in terms which are absolutely unambiguous.

Yet it is by no means unknown for a purchaser to invite tenders for the supply of, say, a '20 per cent. endrin solution'. He may receive bids from two or more suppliers and he may come erroneously to the conclusion that one of these suppliers is offering the cheapest product. The fact may be that this supplier is offering a solution which contains 20lb. of endrin per 100lb. of solution (i.e. 20 per cent. w/w), whereas his competitors are offering supplies of a solution containing 20lb. of endrin per 10IG (i.e. 20 per cent. w/v).

The specific gravity of this (latter) solution may well prove to be about 0.9, so that 20lb. of endrin will be contained in 90lb. of solution, and if this is so, a simple calculation will show that the solution containing 20 per cent. w/v of endrin, also contains 22.2 per cent. of endrin by weight. Thus, if the quotations were viewed on the same basis, it might well be found that the higher quotation nevertheless represented the best value. Conversely, on account of a similar misunderstanding, the formulator may find himself supplying a product which contains substantially more of the insecticide than was required by the purchaser.

The errors which would arise from a failure to define the term 'gallon' are more obvious.

# Modern Seed Dressing Methods

*by* **A. Hedén,** *A.B. Casco, Stockholm.*

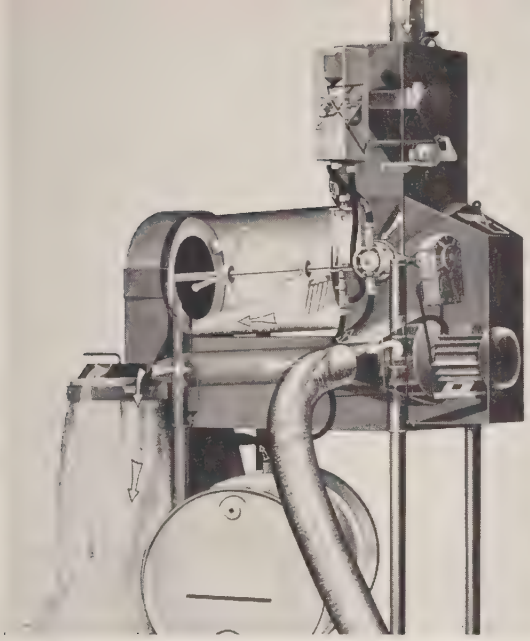
*Experience with organo-mercury compounds for the control of fungal diseases during the past 40-50 years has shown that these compounds are probably the best universal fungicides yet known. They are used as seed dressings, in drenches for soil disinfection and as foliage fungicides for the control of apple scab and to some extent also against late blight of potatoes. In the following article their use in controlling different types of seed-borne diseases, by applying them as seed dressings, is discussed.*

With the gradual improvement in agricultural techniques that have occurred over the past 30 years and the increasing mechanisation and centralisation of farming operations, there has been a growing demand for a method of treating large quantities of seed with protective chemicals in a rapid and hygienic way.

Most dust seed dressings contain only low volatile mercury compounds in order to reduce the toxicity hazard to a minimum, or they may contain a mixture of the low and high volatile compounds. In order to make these formulations, which are of reasonably low volatility, as active as possible, the size of the dust particles is very small—about the same as those in tobacco smoke—which means that they remain suspended in the air for a long time and thus are a source of hazard to the workers. Various methods are employed to reduce this hazard but none is entirely successful. This is one of the reasons for the importance which is now being attached to the development of liquid seed dressings.

In 1939 Zade introduced a method which he called 'dry dressing with a liquid', an idea on which he had been working for several years. He had started from the investigations of Gassner (3) which showed that methyl-mercury was a better fungicide and also had a wider margin of safety between the effective application rate and the phytotoxic dosage than other organic mercury compounds. Working independently of each other Zade and Gassner came to quite different conclusions in their efforts at making a liquid seed dressing. Zade's new discovery was that he found it possible to obtain good distribution with very small amounts of liquid (2ml/Kg). Gassner (4), in his 'short-wet' method, had been able only to come down to dosage rates of about 10 times those used by Zade, if effective results were to be obtained. Later investigations by Lindström (6) have confirmed Zade's results and shown that a further reduction of the dosage to one-tenth of that used by Zade is possible without loss of efficiency in distribution.

To be able to use all the advantages of Zade's invention a special treater had to be made. This was done by fitting a liquid seed treater with measuring equipment capable of accuracy of treatment to within 1-2 per cent. error.



*A liquid seed treater.*

*Fusarium-infected wheat:* left, *untreated;* right, *treated.*

Lindström has shown that initial distribution of the liquid must be good to obtain dispersion of 98 per cent. of the mercury evenly over the seeds. With this machine the hazard to the operators was minimised.

In a liquid seed dressing formulation it is possible to use mercury compounds of a higher volatility than can be used in dusts, as the hazard in the case of liquids depends only on the volatility of the material, and this hazard can be reduced to a safe level by fitting an efficient extractor fan to the treater. In addition, it is easier to apply an accurate dosage with a liquid than with a dust, since the dosage of a dust while dressing seed may be affected by the humidity of the atmosphere.

When Gassner discovered the biological advantage of methyl-mercury iodide, he concluded that all methyl-mercury compounds would be as dangerous as the iodide which he had used in his trials. Later investigations, however, have shown that while the fungicidal activity as well as the phytotoxicity are chiefly bound to the radical of the molecule (2), the vapour pressure, and thus the hazard to humans, depends on the whole molecule (6). Most liquid seed dressings contain methyl-mercury compounds of fairly low volatility, but the vapour action is sufficient to give a good distribution over the seed, since a liquid is able to act from the whole area of the seed, while a dust can act only from the projection of the particles. With the improved distribution compared with a dust, liquid dressings are usually more effective fungicidally.

**Seed-borne Diseases**

For convenience, the seed-borne diseases may be divided into five groups according to the growth habits of the diseases, their degree of sensitivity to mercury, and therefore the seed treatment used to control them.

The first group comprises mercury-sensitive fungi, which under some climatic conditions are only seed-borne and infect the seed with spores on the surface. These spores do not grow until the seed is sown, and infection occurs in the seedling stage when the spores on the grain germinate at the same time as the seed. The mycelium passes into the plant stem and grows with the plant. Diseases of this kind, such as bunt of wheat, *Tilletia sp.*, and some species of smut, are easily controlled by most organo-mercurials.

In the second group there are fungi which are normally sensitive to mercury. During the later period of growth, however, they penetrate the outer layer of the seed coat and thus become more difficult to reach with seed dressings. For the control of these fungi the liquid formulations are decidedly better, for with their somewhat higher vapour pressures and much more effective vapour action, they are capable of killing the deep seated mycelium. The most typical representative of this group is loose smut of

oats, *Ustilago avenae*, which grows with a promycelium between the kernel and the husks. Many fungi (*Fusarium* spp. on many kinds of seed and *Phoma betae* on beet seed, for example), which under normal conditions belong to the first group, may, if the infection occurs early after flowering, result in a deep seated infection.

The third group of seed-borne diseases comprises fungi which are moderately sensitive to mercury. Many of these are pure saprophytes, but under certain favourable conditions some of them can also act as parasites. *Aspergillus niger*, the main cause of crown rot of peanuts, is normally a typical mould fungus, which in this case acts as a primary or secondary parasite. Other representatives of this group are *Botrytis cinerea*, causing grey mould on several plants, and also some species of *Penicillium* which live parasitically on mechanically damaged wheat. Trials in East Africa for the control of crown rot have shown that a liquid mercury dressing can give the same plant stand as mercury dusts and better control of the disease (equivalent to the control obtained with TMTD).

**Tropical Conditions**

In the fourth group are found many fungi belonging to the first two groups, but under tropical and sub-tropical conditions these fungi are not only seed-borne but may also be partly soil-borne and air-borne. This is very typical, for normally, where a disease is seed-borne, as one moves from temperate to tropical conditions, the same disease tends to become soil-borne or air-borne. Diseases within this group attack cotton, rice and other seeds which are usually dressed with various types of mercury compound. For the control of damping-off fungi, seed dressing gives good results when, as a result of favourable weather conditions, the stage at which the plants are most susceptible passes quickly. But if germination is slow, soil infection will predominate, resulting in inferior control of the disease, mercury dressings being somewhat limited in their action against soil-borne infection.

Generally there are very small differences in action between mercurial dusts and liquids in controlling partially seed-borne diseases; but by giving better control of the seed-borne infection, liquid seed dressings usually produce plants that have less infection during the later stages of growth.

In Austria, trials have been carried out with seed treatment against leaf spot of beets, *Cercospora beticola*, which results in a secondary infection with air-borne spores. The disease was estimated as the number of sampled leaves having more than 300 spots: the result showed 1,053 infected leaves for the untreated crop; 873 for the crop grown from dry-dressed seed; and 714 for the crop grown from seed treated with a liquid mercury dressing, Panogen.

In the last group are found fungi which, because of their mode of infection, cannot be controlled with any chemicals. Fungi of this type include loose smut of wheat and barley, *Ustilago tritici* and *U. nuda*, which infect the embryo at flowering time and can only be controlled by warm water treatment.

**Phytotoxic Action**

According to Croisier and Midyette (1) phytotoxicity of mercurials depends on the following factors: (i) moisture content; (ii) temperature; (iii) type and quantity of fungicide applied; (iv) type and duration of storage; and (v) condition of the seed coat.

As regards the third point, there has been found to be no difference in phytotoxicity between a dry and a liquid form of a mercury compound when the chemical is applied at the same dosage rate. The critical dose at which phytotoxicity is caused by methyl-mercurials is much higher than for other mercury compounds, as methyl-mercurials are used only in liquids, and these dressings are usually less phytotoxic than the dusts. With the mercurials in use to-day there is always a certain margin of safety when dressing seed of good quality, but to be sure of a good result with poor quality seed the safety margin must be as wide as possible.

Seed dressings have become a very popular means of plant disease control as they are easily applied at a low cost in comparison with other crop protection measures. In Denmark, where seed dressing has been established for several years, trials have shown that treatment of apparently uninfected cereal seed often results in a higher yield (60-100 Kg/ha more) than is obtained from untreated seed, even when the plant stand has been the same for treated and untreated, or has been increased by only one to two per cent. by the seed dressing. The implication is, of course, that diseases which are probably of importance during the development of the plant, but are not visible at normal germination analyses, are controlled by seed dressing. From the economic point of view it means that by dressing cereal seed, a minimum return of at least 12s.-20s. in higher yield should be obtained for a cost of about 1s. 6d. per acre for fungicidal material.

For the future, it may well be that active materials such as systemic fungicides and insecticides will increase the sphere of action of seed dressings based on organo-mercury compounds.

**REFERENCES**


1. Croisier, W. F. and Midyette, Jr., J. W. Mercury poisoning of wheat seed. *News Letter*, Assoc. Off. Seed, **29** (1), 14-19, 1955.
2. Czerwinska, E., Eckstein, Z., Hetnarsky, B., Kowalik, R., Sadurska, J., Urbanski, T., *Bul. l'acad. pol. sci., Sci. chim. geol. et geogr.*, **6**, 6-18, 1958.
3. Gassner, G. *Arbeiten aus der Biologischen Reichsanstält f. Land und Forstwirtschaft*, **2** (5), 1923.
4. Gassner, G. *Angewandte Botanik, Zeitzscrift fur Erforschung der Nutzpflanzen*, **9** (1), 1927.
5. Krexner, R.: Neues über die Beizung des Rübensaatgutes. *Pflanzenartz*, **12** (3), 33-34, 1959.
6. Lindström, O. *Ag. and Food Chem.*, **6**, 283-298, 1958.

*Inhalation of insecticidal fogs should be avoided, especially when they are being applied indoors. If the chemical constituent is highly toxic, protection can be gained from the enveloping fog by the use of a gas mask. Hair and clothing should be covered with a washable hat and cotton overalls.*

# HANDLING PESTICIDES SAFELY

In industry it has long been recognised by both management and labour that the wearing of certain protective clothing is an essential precaution against accidents. Coalminers, for example, wear helmets and safety boots; welders wear goggles; many factory workers wear industrial gloves.

As in industry, so now in agriculture, for the development of modern pesticides since the last war has brought with it the need for farm workers to take reasonable precautions against contamination—and, in some instances, poisoning—by toxic substances. It is primarily the degree of mammalian toxicity of a pesticide that determines the precautionary measures which the manufacturer recommends to users of a particular chemical to ensure its being safely handled.

In the United Kingdom, the Ministry of Agriculture has laid down stringent regulations designed to protect farm workers against poisoning by the more dangerous compounds, and similar regulations are in force in the USA.

Precautions are largely dictated by commonsense, and include keeping insecticides under lock and key; wearing items of protective clothing such as goggles, respirators, gloves, overalls, and rubber boots; observing correct dosage rates; looking after equipment; and safely disposing of used containers.

Usually the critical question as regards safety requirements is: 'how well are they observed: do users of toxic chemicals take all recommended precautions or just "trust to luck"?'

The photographs on these pages show that the risks to users do not depend only on the toxicity of the chemical: the formulation and method of application employed, and the growth habit of the crop itself are also seen to be important when it is remembered that poisons can enter the body by all or any of three routes: the skin (by absorption); the respiratory tract (by inhalation); and the mouth (ingestion).

*Mixing and handling the concentrate. Risk is mainly through dermal absorption. Gloves, boots and apron give protection against splashing and spillage. All stirring should be done with a flat wooden paddle.*

*Applying a high concentrate dust. The risk of inhalation is probably greater with dusts than with other formulations, and the use of a face mask is desirable. Overalls and hat give protection against the dust deposit.*

*When spraying grown crops with toxic insecticides, contamination can best be avoided by wearing boots, gloves, and cotton overalls with long sleeves and buttoned at the neck.*

*After spraying with any insecticide, whether non-toxic or highly toxic, the equipment should be thoroughly washed and cleaned down.*

*Tractor-mounted power take-off driven sprayers can quickly drench the operator in a wet mist. Waterproof overalls, hat, visor and rubber boots give complete protection against dermal absorption, the chief hazard when highly toxic chemicals are being used.*

*When applying insecticides with a motorised knapsack sprayer to a tall crop, the spray operator is exposed to dermal absorption and, to a lesser extent, to intoxication through inhalation. Full waterproof clothing gives protection against any spillage, drift or contact with sprayed foliage. The visor protects the face from spray. In tropical climates cotton clothing can be used, so long as it is frequently washed.*

*To give maximum protection, protective clothing and equipment must be in first-class condition. It is essential that all items are washed thoroughly after each period of spraying, or at the the end of each working day. Care must be taken to see that all clothing and gloves are dry before being packed away.*

**Insects and Their World.** HAROLD OLDROYD. British Museum (Natural History), London. 7s. 6d.

In recent years a number of books of an elementary nature have appeared in response to a growing public interest in insects, created and fed by television, magazine articles, evening classes and perhaps even some unfortunate horror films. In nearly every case the value of these books has been reduced by over-emphasis on some particular aspect of entomology, usually insect classification. By avoiding this pitfall Mr. Oldroyd has provided us with what is perhaps the best of this type of book to appear so far.

Within the compass of 139 pages this little book presents a concise picture of the insect world which should be of great assistance to anyone wishing to acquire a working knowledge of insects, but who feels unable to digest the more weighty text-books. The first chapter explains the classification of insects down to the level of Orders. The characteristics of each Order are briefly described and, where possible, members of the Order familiar to the layman are described and illustrated as examples. The succeeding four chapters deal with the structure of the insect body and the function of its various parts in just sufficient detail to build up a clear picture of the insect in the reader's mind. It is worth noting the admirable manner in which the unavoidable technical terms are woven into the account, so that the text reads smoothly without continual recourse to a glossary.

The concluding chapters contain an account of insect behaviour, with special reference to the complex patterns of behaviour found among social insects, a short essay on the amazing diversity of form and function found among insects, and finally a chapter discussing the relationship between man and the insect. In view of the growing importance of insect pests, particularly pests of food crops, in this overpopulated world, one feels that the final chapter could have been dealt with in greater detail.

Criticisms? The illustrations throughout the book are generally of such a high standard that the occasional lapse is all

the more glaring. With the resources of the Natural History Museum at the author's disposal would it not have been possible to select a less tipsy specimen of a solitary wasp than that illustrated on page 91 ? And what a pity that such a widely useful book could not have been given a more durable binding.

D. G. COCHRANE.

**The Living House.** GEORGE ORDISH. Hart-Davis, London. 25s.

This book provides a fascinating account of the ecology of a farmhouse set in the Kentish Weald, from the time it was built in 1556 until the present day. Mr. Ordish's obvious enjoyment in writing it is at once infectious and refreshing, and there is a wealth of information set down in a style which cannot fail to maintain the interest of the reader, whether biologist or not.

The absolute interaction between animals and their environment is brought home as the author traces the effects on the animals inhabiting it, of the original design of the house, the repairs, disrepair and modifications throughout its history; and as he shows that these changes in the environment are in turn associated with the actions of, and qualitative and quantitative changes in, the inhabiting population. Again, the animals themselves are shown to be interdependent to a greater or less extent, and ultimately all, either directly or indirectly, to be dependent for their existence on plants, which alone can assimilate the basic ingredients of life.

In this process the human occupants enjoy no exclusivity. They may control the environment and yet it is the environment which controls them. This fundamental truth, which man in his superiority tends to overlook, could scarcely be better illustrated than in *The Living House*. In addition, the author has inserted a great deal of incidental biological information (incidental but not superfluous) which will prove fascinating to those not already aware of it. Perhaps a fault of the book is that so much information is given in so short a space that, in parts, the reader is left almost breathless; but it is a fault which can easily be forgiven. Again, one wonders how much of the historic detail of the various animal populations is derived from recorded information and how much from conjecture. In this respect it would have been of interest if Mr. Ordish had published the sources of his research.

The author first describes the events leading to the siting of the house and the effect of the times in which it was built on the design, method of construction and materials used—important in that this provided the basic environment which, in association with later modification, was to determine the subsequent inhabitants. The succession of inhabitants is then described—the wood borers, some of which were already in the building materials before construction; the mammals, wild, domestic and human; the spiders; the birds; the various parasites; and the part-time inhabitants such as mosquitoes, butterflies and toads. The account given of the habits, life-cycles and history of these animals is at the same time informative and fascinating.

Finally the author summarises the evolution of the inhabitants throughout the history of the house and attempts to open the curtains on the future. In this he points out that while man cannot be divorced from the ecology, he is in a unique position of being able to exert a conscious control on the environment, either directly or indirectly. He can learn from the past and act in the present in planning for the future. By being aware of this and 'using his gifts with sense and goodwill' he reaches the ultimate in his existence. It is an unfortunate human failing that mankind is not aware of the full implications of his actions. He is by nature self-centred and short-sighted. The importance of ecology is too often forgotten and in stimulating a wider outlook alone this book will be of value in agriculture, as in any walk of life.

I. D. FARQUHARSON.

**Agricultural Insects of East Africa.** R. H. LE PELLEY. East African High Commission, Nairobi, Kenya. 42s.

This compilation of East African plant feeding insects and mites, with their plants, their parasites and predators, covering Kenya, Tanganyika, Uganda and Zanzibar, fills a long-felt

need and forms a very useful hand-book for the many entomologists who in one capacity or another are concerned with the African insect world. Useful, too, are the records of stored product insects and of the insect parasites and predators which have been intentionally introduced into the area. These show that of the 50-odd species of parasites and predators introduced, half-a-dozen have become established, exerting a good control of the insect pests against which they were liberated.

For the economic entomologist needing a quick reference work it is perhaps disappointing that no indication is given of the economic importance of various insect pests nor of the type of damage which is caused, since such information would have been particularly valuable for many lesser known pests. The extensive bibliography containing 656 literature references will, however, give further guidance in this respect in the event of any queries.

One feels, bearing in mind for instance the Nyasaland records, that in the years to come the list will grow and will have to be revised from time to time. At the same time many copies of the present edition will become well thumbed and it is to be hoped that the 'poisonous insecticide solution' which, we are told, 'has been used for binding this book' will withstand the attack of termites, wasps and other insects which seem to thrive in tropical libraries. A. M. H. SANGER.

**Horticultural Pests: Detection and Control.** G. FOX WILSON (new edition revised by P. BECKER). Crosby Lockwood, London. 25s.

More than 10 years have elapsed since the second edition of G. Fox Wilson's book, *The Detection and Control of Garden Pests*, was published. During this period, some very notable developments have taken place in the field of chemical crop protection. Many new and potent organic insecticides have been synthesised, tested and made available to the grower and gardener, and significant advances have also been made in methods of application of insecticides. The general scale of use of chemical control measures against weeds, fungus diseases and insect pests has also extended enormously.

It is, therefore, particularly gratifying to note that, in preparing the third edition of this book, Dr. P. Becker has made a determined and successful effort to bring his readers right up to date on the subject of chemical warfare against pests. His treatment of this subject is all the more commendable in view of the rapid changes and developments which are constantly taking place.

The properties and recommended uses of all the new insecticides which are currently available are mentioned in the section dealing with control measures, and the older materials, some of which still have their uses, are not forgotten.

Alternative control measures when available are recommended for each pest, but these are not presented in any order of merit. Some indication of preferred treatments might be helpful in some cases. For instance, dipping the roots of brassica plants in aldrin or dieldrin when transplanting is a much more effective remedy against cabbage root maggot than drenching with these insecticides after planting out. Similarly a broadcast dust or overall spray of dieldrin to the soil before preparing the seedbed provides the best possible control of carrot fly. Incidentally, this latter control measure is not mentioned.

Prevention is better than cure, and useful information is given on cultural control as a means of avoiding pest infestation by good and thorough cultivation, rotations, adjustment of sowing dates, balanced manuring and hygiene.

The importance of avoiding the unnecessary destruction of beneficial insects such as ladybirds and lace-wing flies, and the indiscriminate use of insecticides is very properly stressed, but many gardeners might be reluctant to accept the suggestion that they should allow a certain degree of damage before using insecticides in order to enable the beneficial insects to play their part. The beneficial insects do not always turn up!

Under the heading of "control measures", a section dealing with the relative merits of different methods of applying insecticides for various purposes might be helpful in future editions. The value of seed dressings and other methods of applying limited quantities of insecticide where they are most wanted may not be generally appreciated as a means of controlling many pests with minimum hazard to predators. Similarly, early spraying with an insecticide will often provide the necessary control before predators reach the target area.

The classification of pest damage under the headings of the parts of the plants which are affected is admirable from the point of view of easy reference, and the photographs and illustrations are most comprehensive and helpful as a means of accurate identification.

It can be said that the task of revising and enlarging G. Fox Wilson's book has been admirably performed by Dr. P. Becker, his successor at Wisley. Commercial growers and horticultural students, as well as amateur and professional gardeners, will welcome the publication of this comprehensive and up-to-date new edition as a valuable reference book on the identification and control of horticultural pests. J. L. HUNT.

**Diseases of Farm Crops.** A. BEAUMONT. Collingridge, London. 25s.

The author of this small book (128 pages) has spent over 35 years in the West and North of England advising farmers, and his practical experience is reflected in every page. This is particularly so when he is writing about potato diseases and potato blight in particular—in fact, Mr. Beaumont has given his name to posterity since the critical conditions of atmospheric temperature and humidity necessary for the development of potato blight epidemics are known as 'Beaumont periods'.

Nevertheless, the diseases of other farm crops grown in the United Kingdom (the book is entirely confined to United Kingdom experience)—cereals, root and fodder crops, beans and peas, pasture and forage crops, grasses, and vegetables grown for human consumption—are by no means neglected. This book is, however, particularly valuable in that it concisely summarises the vast amount of knowledge which has now been accumulated by the Ministry of Agriculture's National Agricultural Advisory Service, and others, on the epidemiology and control of farm crop diseases in the United Kingdom.

Mr. Beaumont deals with diseases caused by nutritional and weather conditions, as well as those caused by fungi, bacteria, and viruses. However, although disease is defined as a 'condition in which the plant shows a departure in appearance from normal', no mention is made of abnormal conditions caused by insect or eelworm attack, although this may frequently produce symptoms, such as wilt, similar to those caused by fungi, or symptoms reminiscent of nutritional disorders.

This book has been written for both the farmer and the agricultural student, and to some extent it has fallen between two stools, being probably too complicated for many farmers and not scientific enough for the advanced student. One criticism is that the arrangement of the diseases in each chapter is unnecessarily confusing: possibly they could have been arranged in descending order of importance or commonness.

And a non-scientific identification key at the beginning of each chapter would have enabled the publisher's claim, that the grower will be able to identify the particular disease, to be better substantiated. However, the actual descriptions of each disease are generally clear and concise, and the photographs (all black-and-white) illustrate most of them well.

The control measures given are admirably clear and practical but inevitably this information quickly becomes out-of-date. Thus in the section of the book dealing with seed disinfestation, no mention is made of liquid seed dressings; and after 1960 sodium arsenite will not be used as a potato haulm killer in the UK. The examples given of commercially available products also severely 'dates' the book, and it is to be hoped that, in the future, when the new Agricultural Chemicals Approval Scheme is in operation, a text book such as this need only mention the active chemical, the farmer then being able to refer to his current list of approved products to find which commercial pesticides contain this ingredient. The lists of resistant and susceptible crop varieties are also already somewhat out-of-date, as the introduction of improved varieties follows thick and fast.

In spite of certain undoubted shortcomings, this book is likely to be welcomed by students as a concise and readable account of farm crop diseases in Britain. Because of the somewhat complex presentation, however, it may prove less useful to farmers. B. J. T. BALDWIN.

**The Application of Genetics to Cotton Improvement.** SIR JOSEPH HUTCHINSON. Cambridge University Press. 15s.

This modern synthesis of knowledge on cotton research amplifies and revises opinions held by Hutchinson, Silow and Stephens in *The Evolution of* Gossypium (1947).

It is a scholarly work which has included all evidence which might be expected to throw more light upon the history of the genus *Gossypium* and the development of the present day commercial crop. A complete account is given of the wild relatives of cotton including genera other than *Gossypium*. In one very important respect the evolutionary story of the cottons differs from the earlier account. *G. herbaceum* race *africanum* is regarded as a truly wild species and closely related to that first true-linted species from which all others were derived. So although the diploid cottons diversified in India they originated in South Africa. The allopolyploid ancestor of the New World cottons is considered to have arisen in North Peru as the result of a chance hybridisation between a relative of *G. raimondii* (*D* genome) and an early *herbaceum* (*A* genome) cultivated cotton brought there by man.

Sir Joseph Hutchinson in this account makes no mention of Wegener's *Theory of Continental Drift* which in the earlier *Evolution* was invoked to explain the distribution of the wild species. It still seems to the writer the most attractive explanation of the occurrence of the *D*'s in Central America and the *C*'s in Australia. The original allopolyploid could also have arisen in West Africa at that point where the African continent most neatly fits into the Caribbean region. The present limits of the distribution of *africanum* does not seem to be a strong enough argument against its forebear occupying a more westerly and central position adjacent to the *D*'s in some former time.

In discussing the great diversity amongst the cultivated diploids the author comments upon the low variability which must have been present in the original relative of *G. herbaceum* race *africanum* which was domesticated. This variability need not have been quite so restricted. At that time the genus was younger and more vigorous—not yet represented by a series of relict species. The mutation which gave rise to true spinnable lint no doubt spread considerably before it was utilised by man. This early utilisation was no doubt due to randomly gathered lint from naturally occurring bushes—it would have been some considerable time before conscious cultivation took place and then probably with seed from widely separated sources.

The evolution of the crop as distinct from its origins out of the wild species is dealt with in an exhaustive fashion showing the tremendous changes brought about within species by man's selective pressure. This is exemplified in the selection of the annual habit out of a perennial crop, which enabled the limits of cultivation to be extended to those regions where cold winters would exclude a perennial plant; in the classical work of Knight in selecting and identifying resistance factors to bacterial blight; and in the utilisation of hair of suitable length and density for resistance to jassid.

In the chapter on breeding systems, the author deals with the most efficient ways in which the variability of the crop can be utilised. The methods which he himself pioneered in making use of genetic information and statistical tools have led to the very precise methods used by Manning in Uganda today where advance in the crop is obtained by use of a discriminant function technique for developing a selection index. This has been highly successful. This chapter also makes the point that useful genes may be passed successfully from one species to another so long as the greater part of the genotype of one or the other species is retained. Any attempt to hold a genotype midway between species is doomed to failure.

The story of the improvement of African cottons is one of an amazingly rapid advance. Genetic diversity has allowed selection to be successfully practised for innumerable sets of conditions. There is no sign that such diversity is at an end.

This book provides a vivid illustration of how much there is to learn about a crop; and it shows that when such knowledge is sought in its entirety—historically, taxonomically, genetically, physiologically and not least agronomically—as it has been in the case of cotton, the practical rewards are proportionate. Sir Joseph Hutchinson's account is a stimulus to all those working actively in cotton research today. J. H. SAUNDERS.

**Fundamentals of Forestry Economics.** W. A. DUERR. McGraw-Hill, New York, Toronto and London. 74s.

Professor Duerr, of Syracuse University, New York, wrote this text book for the benefit of students both in and out of college. The economics of forestry is an expanding field of activity and his view is that in the current environment economic questions are thrust on the individual in many ways. It is thus necessary to understand a variety of such questions in order to be an intelligent participant in the development of forestry or even to be an intelligent witness to these activities.

The volume is divided into five main sections involving 33 chapters. In the introduction the question of how forest lands and related human and industrial resources are allocated or managed is considered from the point of view of the witness trying to describe human behaviour, and of the consultant offering guidance on social or individual policy. The second section on the firm's supply of forest products is concerned mainly with the structure of the industry: the firms that supply forest goods and services, the principles influencing the combination of the factors of production, the supply responses to costs and prices, and methods of economic planning. The third section, on the market for forest products, concerns itself with supply and demand, price and quantity effects, the functions and

agencies of marketing, and evaluation of marketable and unmarketable products.

The human institutions which influence economic activity are the main concern of the fourth section. These include centres of influence in business, trade unions and Government, land tenure, taxation, credit and insurance. 'Operation and planning of the forest economy' is the title for the final section, which covers the forest economy of the world, social planning for the forest economy, planning public forestry programmes, regional planning and the general economic problems of forestry.

One may wonder why it is at all necessary to write a special volume on the economics of forestry since economics is a discipline which has relevance for all industries. Would it not suffice to provide discussion on some selected aspects of economic theory which have special importance in forestry?

From his own experience Professor Duerr has attempted to sift the fundamentals and sort them into principles. He uses illustrations which are mainly American and has adopted a rather 'chatty' style of presentation. He has assumed that the reader has been introduced to some forestry subjects and that he has had one or two terms of introductory economics. In view of the latter assumption it is rather surprising that he has frequently found it necessary to explain some general economic concepts. It may well be that there is some advantage in having a comprehensive link with the theory of economics and the practice of forestry, as otherwise the enthusiasm and effort needed to link arguments may wane for a general forestry student who has to spread his interest over a variety of courses. The volume is designed so that it can meet a variety of special requirements: for example, a general survey of the micro- and macro-economics of forestry, production economics, financial aspects, marketing and prices.

An interesting feature is that where many of the special terms are used for the first time they are put in bold type in the text and in the page references of the index, which thus also functions as a glossary. Another innovation is that whereas many text books provide lists of questions for study at the end of chapters, here they are dealt with as they arise and are put in brackets. For the type of student who wishes to become familiar with some basic concepts of economic theory, and who at the same time wishes to increase his understanding of forestry problems, this publication has many advantages. A selection of relevant aspects is made by a professor of wide experience and he contributes a useful analytical approach. Each chapter carries a summary and there are many graphs and tables.

J. J. MacGregor.

**Polythene Film in Horticulture.** H. R. Spice. Faber, London. 18s.

The use of plastics in agriculture and horticulture is becoming increasingly common; this applies particularly to plastic film, of which sufficient was used by market growers in the United Kingdom in 1957 to girdle the equator with a band three inches wide.

This book is published, therefore, at an opportune moment, for the quantity of film used for horticultural purposes is increasing every year. The most general use for plastic film is as a replacement for glass in greenhouses, cloches and frames, and for the lining of glasshouses to retain heat and eliminate draughts. The author deals with these subjects in considerable detail and discusses such topics as the choice of film, its length of life, costs, and methods of fixing to supports.

Plastic film has certain advantages and disadvantages when compared with glass and the author lists these as follows.

*Advantages:* (1) low initial cost; (2) the light weight of plastic film makes the use of large frames and panels possible (frames can be of a larger area and more easily handled than is possible with glass); (3) as plastic film is flexible, new shapes and designs of the framework are possible; (4) largely as a result of the above, polythene makes possible the protection of crops which could not be covered economically with glass.

*Disadvantages:* (1) plastics deteriorate slowly in sunshine. As a protection is of the greatest value in the early and late months of the year, this limitation is less important than it seems at first sight, especially as the life of the plastic cover can be prolonged by keeping it in the shade during the height of the summer; (2) as a general rule, crops under plastic ripen later than those under glass, and plastics do not offer such good protection against frost; (3) ventilation, and the condensation of moisture on the polythene, can present problems not associated with glass; (4) because plastic film is so light in weight, the possibility of wind damage is more likely.

Undoubtedly some of the disadvantages will be eliminated in the near future by the production of plastic films which are less susceptible to damage by ultra violet light and whose strength will be such that they will be able to resist being torn by the wind.

In addition to the use of plastic film as a replacement for glass, the author gives details of other uses for plastic pipes and films, such as irrigation; hot air heating and ventilating of greenhouses; reservoirs; mulching; flower pots; plant propagation; wrapping of fruit and vegetables; covers for use in soil steam sterilisation, etc.

An interesting and original use is to slip a length of perforated plastic film tubing over immature cucumbers and tie round the stalk. As the cucumber grows, the film expands, so that when the fruit is ready for cutting, it is already prepacked. As the author states, 'development of this technique might lead to a Utopian state of affairs where the grower is enabled to produce fruit of specified shape, size and weight by using tubes or bags of the correct substance and diameter'!

Horticulturalists will find a wealth of information in this book regarding the relatively new use of plastic materials and it should be of considerable assistance to those growers who are contemplating the use of plastic film. In addition, it should be of help to growers who are using film already, in pointing out additional uses for this material.

R. J. Collier.

**Dictionary of Agriculture.** Günther Haensch and Gisella Haberkamp. Crosby Lockwood, London. 85s.

This is a four-language dictionary—German, English, French, Spanish—of words and terms used in every branch of agriculture, from administration and legislation (*International Wheat Council*, for example) to detailed technical words and expressions (e.g., *tandem disc harrow; "approval is compulsory for" . . .*). As the dictionary is of German origin the German word is always given first, followed by the equivalent in the other three languages.

The dictionary has been assembled systematically in 14 sections, each dealing with a different aspect of agriculture, and these sections are further subdivided. Each sub-section is arranged in alphabetical order of the German words.

Following the main body of the dictionary are separate alphabetical indexes to every word and expression included in each of the four languages, so that it is easy to look up a word in any of the languages.

The work is completely up-to-date and is stated to contain 35,000 references.

## Higher yields on Honshu

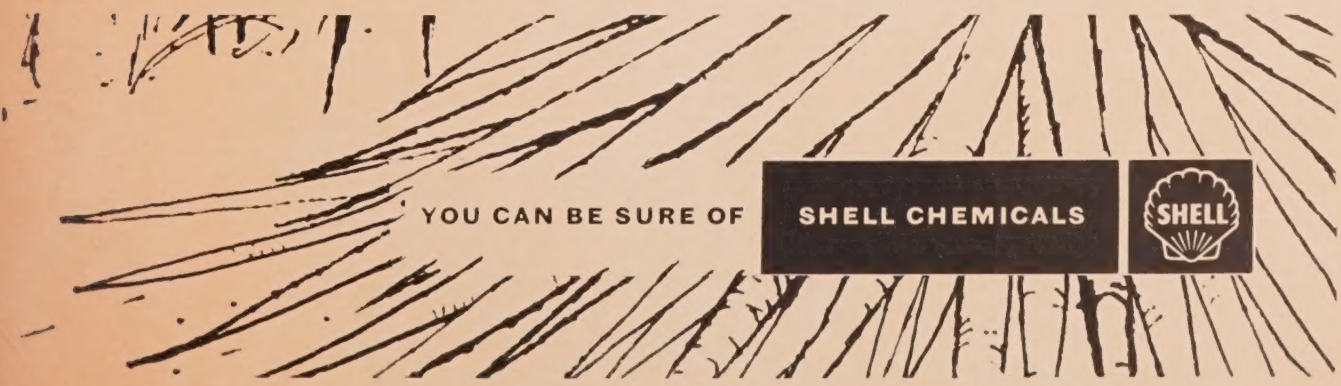
Around Aichi on Honshu, the largest of the Japanese islands, the same crop goes into the same soil over and over again. This is a system favourable to the Japanese agricultural economy and one much liked by *Meloidogyne incognita* var. *acrita*. the root-knot nematode. In such conditions nematodes thrive and their presence in the Aichi soil slashed carrot yields by half.

In pesticide trials carried out to beat this scourge, Nemagon proved extremely successful. Ten days before the carrot seed was sown, this effective Shell soil fumigant was injected into the earth. Then, after two months' growth, the carrots were lifted. They showed virtually no signs of damage, weighed nearly double those from untreated soil, and were of greatly improved quality . . . concrete evidence of Nemagon's efficiency.

Nemagon shows equally productive results on other crops. It can be applied after planting as well as before and, in this way, effectively controls nematodes in land growing perennials. D-D, Nemagon, aldrin, dieldrin, endrin and Phosdrin can control nearly every world pest.

**Nemagon** *Trade Mark*

*Issued by Shell International Chemical Company Limited.*
*For further information consult your Shell Company*
*(in the U.K., apply to Shell Chemical Company Limited).*



SHELL PUBLIC HEALTH AND AGRICULTURAL NEWS

# span

SHELL

Published by Shell International Chemical Company Limited, St. Helen's Court, Great St. Helen's, London, E.C.3.

Printed by W. R. Royle & Son Limited, 207/229 Essex Road, London, N.1.